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Molding Machine That Throws Sand

Description of a Device in Which the Projectile Principle is Employed for Ramming Sand—Sand Thrown by Rapidly Revolving Head—Stationary and Tractor Types Designed

BY PAT DWYER

WHEN an experienced molder wants to ram a deep pocket in a pattern, he throws the sand in place, a handful at a time. It needs no further ramming. This principle has been applied in an unusually interesting type of molding machine invented by E. O. Beardsley, 747 Irving Park boulevard, Chicago, and W. F. Piper, 538 South Oak Park avenue, Oak Park, Ill. A number of these machines have been in operation several months in various Chicago foundries, including the plants of the International Harvester Co. and the American Brake Shoe & Foundry Co. and rather unusual results have been achieved.

The Beardsley & Piper machine represents a radical departure in molding machine design, although it may be said to be a development of the gravity type. But instead of depending on the latter force for correct ramming, the sand is thrown into the the mold at high speed by mechanical means. It follows naturally that a large quantity of sand can be handled per unit of time and that under suitable conditions finished molds should be turned out with extraordinary rapidity. It also is relatively easy to regulate the density of ramming.

In a measure at least the original features of this machine probably result from the fact that the inventors tackled their problem without preconceived ideas, and based their efforts on their practical foundry experience rather than on any precedents in the field of machine design. If machines of the jolt-ramming and squeezer types have endowed the molder with a giant's strength, the invention of Messrs. Beardsley & Piper, caapble as it is of ramming seven cubic feet of sand per minute, may be said to have the effect of equipping him with seven league boots.

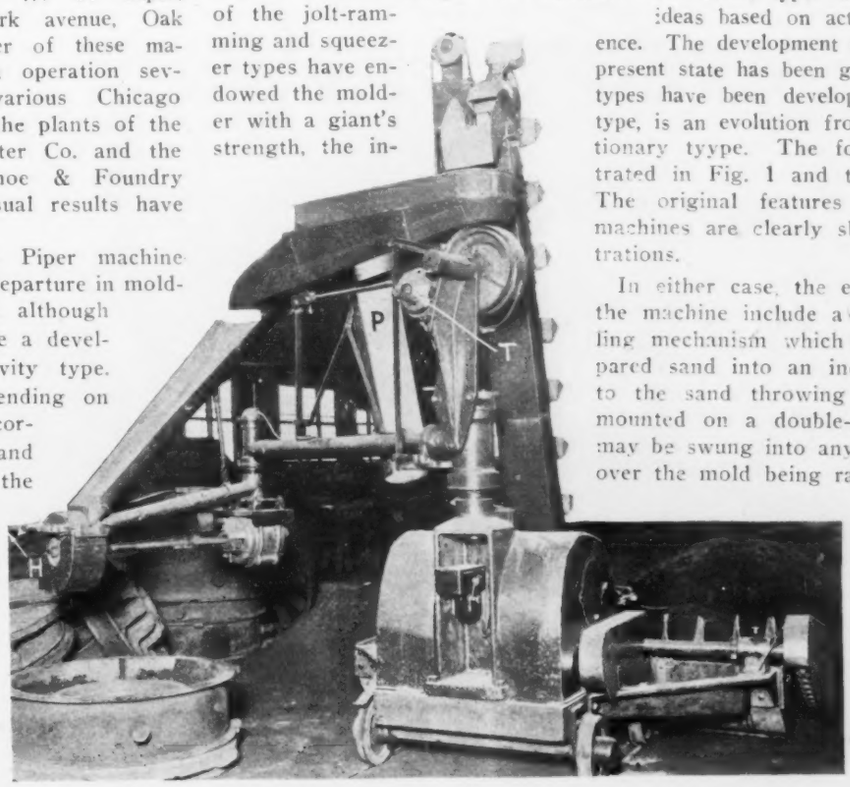


FIG. 1—THIS MACHINE RAMS SAND BY THROWING IT IN MUCH THE SAME MANNER AS A MOLDER THROWS IT INTO DEEP POCKETS AROUND PATTERNS BY HAND

Since the first machine of this type was constructed in a small California foundry, a great deal of experimental work has been done with the result that the latest types embody a number of ideas based on actual operating experience. The development of the machine to its present state has been gradual. Two standard types have been developed; one, the tractor type, is an evolution from the other, the stationary tyype. The former style is illustrated in Fig. 1 and the latter in Fig. 4. The original features of both types of machines are clearly shown in these illustrations.

In either case, the essential elements of the machine include a suitable sand handling mechanism which discharges the prepared sand into an inclined chute leading to the sand throwing head, which is so mounted on a double-jointed arm that it may be swung into any convenient position over the mold being rammed. The tractor type of machine, in addition, is mounted on wheels and, as shown in Fig. 3, is provided with a screw conveyor and bucket elevator for handling the sand together with suitable mechanism for moving the machine

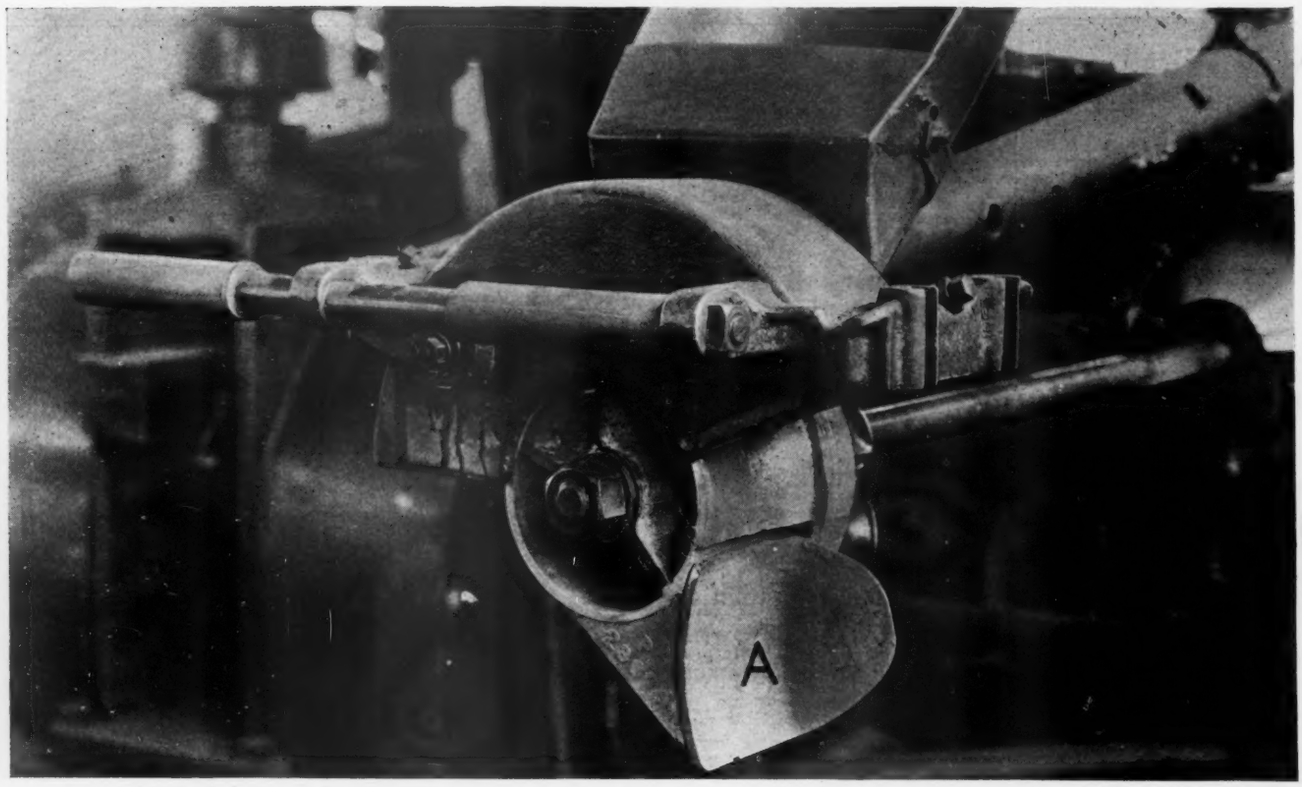


FIG. 2—RAMMING-HEAD OF SAND THROWING MACHINE WITH LOWER PART OF HOOD REMOVED TO ILLUSTRATE DETAILS OF CONSTRUCTION

along the floor. When this kind of machine is employed the sand is arranged in a long windrow on the floor through which the machine moves as the work progresses laying down finished molds in its wake. For this purpose the sand should preferably be prepared by a portable machine of the auto type such as that built by the Sand Mixing Machine Co., New York.

The heart of the machine is the ramming head by means of which the sand is thrown into the molds. It is shown in detail in Fig. 2. The head is connected by a shaft to an electric motor which runs at high speed. The head itself consists of a small drum cast with three arms, on one side of which is a pair of brackets to which the impeller *A*, Fig. 2

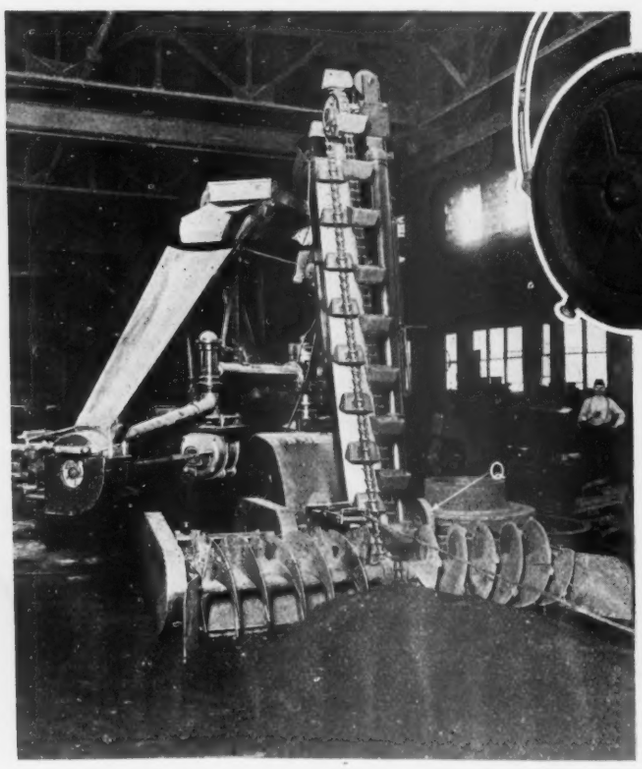


FIG. 3—REAR VIEW OF TRACTOR-TYPE MACHINE SHOWING SCREW CONVEYOR AND ELEVATOR FOR HANDLING SAND FIG. 4—STATIONARY TYPE MACHINE WHICH HAS A RANGE OF 360 DEGREES AND A RADIUS OF 7 FEET FIG. 5—DRAG MOLD FOR A TRACTOR BRAKE WHEEL

is bolted. The impeller is so fastened that it may be adjusted to varying clearances. It is also made detachable so it can be renewed when it is worn out without scrapping the whole head. When in use, the entire sand-throwing head is enclosed in a combination cast-iron and sheet-iron hood as shown in Figs. 1 and 3. The sand enters at the top from the chute and is violently ejected by the rapidly revolving impeller through a hole in the underside of the hood.

From this description it is seen that the machine does not either handle the flasks or draw the patterns. Its function is simply to fill the flasks with sand and ram them. If sufficient flask and pattern equipment is provided and arrangements are made so the machine can work steadily, it is stated it can deliver seven cubic feet of rammed sand per minute. It does not, of course, make any difference what shape or size flask is used and the nature of the pattern is of no consequence. The actual volume of output which may be obtained is dependent in a large measure on the organization of the shop and the facilities available for handling flasks and patterns to and from the machine. This same limiting condition is encountered in the operation of most other types of molding machines.

For ordinary gray-iron work, the inventors have found that the ramming head should run at a speed from 1200 to 1400 revolutions per minute. This speed will ram the sand to the proper density. If necessary, the sand may be rammed at varying densities over the different parts of the pattern and this is one of the principal advantages of the machine. The variation in density is accomplished by passing the ramming head slowly or quickly over the pattern, the slower it is passed the softer the ram. By properly directing the stream, it is a comparatively simple matter to obtain any desired density of ramming up to the maximum possible with any given impeller speed. For making molds for steel castings an impeller speed of 1800 revolutions per minute has been found suitable.

Experiments also have demonstrated the fact that one impeller gives the best results. Heads were tried with two, four and six impellers, but it was found that the density of ramming decreased in proportion to the number of blades.

Ramming sand with this machine is as simple as filling a tub with water from a hose. The operator swings the throwing head into the proper positions by means of the handle *H*, Fig. 1. A constant stream of prepared sand comes down the chute and as it passes through the throwing head the revolving paddle strikes it and drives it into the mold at the proper speed to pack it firmly.

A fairly common job in this country is a sewer ring. Three molds a day, or one every two hours represents a good average output for one man by hand. It is claimed with this machine a man can turn out a complete mold in 10 minutes. This assumes, of course, that proper facilities are available for handling the flasks, etc., and that the shop is working under practically ideal conditions which do not always prevail under ordinary circumstances.

Figs. 4, 5 and 6 illustrate clearly what this machine can do. The molds shown are for 30-inch brake wheels for tractors. Five men, it is stated, regularly put up 300 of these molds every day. They have on several occasions made a complete mold in a minute. The machine on which these molds are made is of the stationary type and the sand is supplied from an overhead conveyor system. The floor is served by an air hoist which carries the molds away from the machine and puts the copes and drags together. The hoist is also used for shaking out the molds. Pouring goes on continuously. The molds are shaken-out over a grating in the floor near the molding machine. The sand drops through to the basement, where it is picked up, reconditioned and returned to the machine by means of a sand handling and preparing system of the ordinary continuously-operating type. The machine shown in Fig. 4 is so designed that the arm carrying the sand-throwing head can swing in a complete circle. The swing of the arm on the tractor type machine, on account of the sand elevator, is limited

FIG. 6—A PORTION OF A FLOOR OF TRACTOR BRAKE-WHEEL MOLDS MADE WITH THE SAND-THROWING MACHINE—FIVE MEN MAKE 300 MOLDS A DAY

to 220 degrees whirh has proved ample for ordinary requirements.

Three motors are provided for operating the various parts of the mechanism of the tractor type machine. The entire control is concentrated in the handle *H*, Fig. 1, which is mounted on the sand-throwing head. This control is similar to that provided on a motorcycle. The functions of the motor connected to the sand-throwing head have already been explained. One of the other two motors is located in the large enclosed hood which surrounds the pedestal of the machine, as shown in Fig. 1. This motor furnishes the power for pulling the machine along the floor and for operating the screw conveyor and sand elevator. The riddle is oscillated by a third motor shown in Fig. 1.

The motor connected to the ramming-head is controlled independently of the other two. It is started by giving the control handle a quarter turn; if the handle is turned half way around all three motors are set to work. This simple interlocking arrangement makes it certain that the sand-throwing head is always in motion when the remainder of the machine is in operation.

The articulated arm which carries the sand-throwing head swings from two pivotal points which are provided with Timken roller bearings. This makes it possible to move the throwing head very easily in any direction in a horizontal plane. In fact, the operation of the machine is said to be quite within the capability of a one-armed man.

The tractor-type machine is pulled along the floor by means of a cable which is shown clearly in Fig. 3. This cable winds around a drum which is housed under the large hood at the base of the machine. The drum shaft also projects and carries the ratchet wheel *Q*, Fig. 3. Immediately over the ratchet wheel is a pawl with its fixed end attached to a pin mounted on an eccentric and its free end resting on the periphery of the wheel. As the eccentric revolves, the free end of the pawl is alternately drawn back and pushed ahead. The result is that the drum carrying the cable is rotated a fraction of a revolution at each stroke of the eccentric. This arrangement of ratchet and pawl is similar to that in use on machine tools for regulating the feed and carriage travel.

The free end of the cable is attached to some suitable anchor at the far end of the floor before commencing operations. Therefore, when the machine is put in motion it gradually winds up the cable and pulls itself along the floor, consuming the sand heap as it moves. The rate of travel is regulated by adjusting the sizes of the gears in the pawl mechanism.

The screw conveyors used for bringing the sand to the bucket elevator are clearly shown in Fig. 3. Even if the sand is not thoroughly mixed in the heap it does not make a great deal of difference because it is turned over 32 times and then riddled before it reaches the mold. The riddle is of the oscillating type and is motor-driven as previously explained. There is a gap in one side of the riddle through which pieces of scrap, etc., are automatically ejected. They fall down the chute *T*, Fig. 1, and are collected in a box carried by the machine.

This machine is protected by the following letters patent: No. 1309833, for molding apparatus; No. 1309834, for method of making molds for steel castings; No. 1309835, for method of making molds for founding; and No. 1309836, for portable machines for making molds. In addition two other patents on this machine have been applied for.

Keeping Record of Iron in Storage

BY D. C. KICKLER

THE method of mixing iron by fracture is rapidly being abandoned, doing away with the rich, high-priced brands to mix with other grades to produce the desired results. It has been demonstrated that the poorest irons can be mixed to almost any degree of softness by the proper use of silicon irons. Then why should the founder continue to mix iron by fracture, when the results produced are not equal to those which could be obtained by chemical analysis?

We are compelled to analyze pig iron because it is deceptive in showing its true grade by fracture, so why should we not mix our irons by analysis, that we may know that we are getting the best mixture most suitable for the kind of castings we produce? But the proper mixtures of iron cannot be made intelligently unless chemical analysis forms the basis of procedure.

It is not safe, as a rule, to depend upon furnace reports of analyses, for the reason that there are many chances for mistakes. These mistakes may be made in numbering iron piles, transferring analysis records from one book to another, mistakes in giving the consumer the analysis from records when the iron is shipped, and in a few instances from the chemist. The writer, on many occasions, has seen serious differences between the analysis received from the furnace and a check from a chemist, after the iron has been received and piled in the yard of the consumer. In fact, in some instances, there has been such a difference that a second sample has been sent for analysis, as an additional check.

Taking the Drillings

For obtaining the best results to check the furnace analysis of pig iron, six or seven pigs should be selected from various parts of the car or pile. These should be broken as near the center as possible, and drillings taken from nearly the center of the fracture of each of the pieces. After this has been done, all the drillings should be thoroughly mixed. To get the best results and to insure clean drillings, these should be handled by a magnet. About one ounce is all that is necessary to send to a chemist.

When pig iron is received by the consumer, each car should be piled separately to avoid errors when using the iron. One of the best methods of keeping the different irons separate, is to separate them with heavy wood partitions, forming stalls. In this way it relieves the expense of piling the pigs. Each pile should be numbered and a pig iron record card, Fig. 1, should be filled out, showing the car number, date received, kind of iron, furnace from which purchased, pile number, analysis, amount of iron received, cost of iron, date, amount used and balance on hand. This provides a perpetual inventory of the iron and relieves the founder of going out in the yard to see what pig irons he has on hand before a mixture can be made. Many officials do not believe in giving their foreman the cost of pig iron and other materials, but I believe this is a mistake, especially if one expects to get the best results from the foreman who is being depended upon to produce the best grade of castings at the lowest possible cost.

Coke also is an important factor in mixing by analysis. Good coke for cupola use should not run over 12 per cent in ash. The ash in coke is an impurity which lessens its commercial value as the percentage in-

creases. Coke also should be as low in sulphur as possible, the best results being obtained when under 0.80 per cent. High sulphur coke may lead to serious results. It usually is safe to figure that about 6 per cent of the sulphur in the coke will be absorbed in the iron, a great deal depending on the length of the heat, especially if the iron is not taken away as rapidly as it is melted. Each car of coke received by the consumer should be piled separately and marked, and a record should be kept similar to that described for pig iron. In sampling coke for analysis, 10 or 12 pieces should be selected from the car or pile. These should be completely pulverized and mixed thoroughly. About one ounce will be sufficient to send for analysis.

Proper handling of the charges cannot be too strongly emphasized, including correct weighing of the coke and irons and an experienced man should do the charging. In the average foundry where the charges run about one ton each, a truck can be used to handle each charge, one charge on each truck. The return scrap can be put on first, then the foreign scrap, followed by the different kinds of pig iron, all according to the weights to which the mixture has been figured. The loaded trucks can be set aside on the charging floor, so that they may be readily pushed to the cupola charging door and unloaded. Handling the charges by this method gives assurance that the right amount of each iron as figured goes into the cupola, avoiding many serious mistakes, such as may happen when the irons are piled close together on the cupola charging floor.

The coke also should be handled on trucks, each truck holding a charge. The coke must be properly weighed. Many tons of coke are wasted by guessing that a receptacle holds a certain amount, or that so many forks full are required for the charge. The writer recently was in a foundry where the men were charging with forks, so many to the charge, and after a check was made, it was found that from 30 to 55 pounds were being charged in excess of the amount reported charged. At this rate the foundry was wasting over 57 tons of coke per year. Iron and coke must be correctly weighed, as guess weights do not permit of running the most economical mixtures. In the average foundry, samples of heats should be taken at least twice per week and sent to a chemist for analysis.

A foundry production report should be made out by the foreman or clerk, showing the cupola charges, result of the heat and the materials used.

This report sheet, Fig. 2, will take care of three different mixtures, as in most foundries it is frequently necessary to make different mixtures during the same heat. Many agricultural implement plants will find this sheet of value, where moldboards, plow points and soft iron are run in the same heat, all from different mixtures.

FOUNDRY PRODUCTION REPORT

Date.....

CHARGE IN CUPOLA				RESULT OF MELT		SUPPLIES USED			
	Wt.	Price	Cost		Wt.	Kind	Am't	Price	Cost
Return Scrap				Good		Coke, Core Oven			
Mchry. "				Bad		" Cupola			
Steel "				Gates, etc.		Core Comp.			
Pile						Flour			
Pile						Kerosene			
TOTAL						Limestone			
						1 Ins. Oil, B.			
						Lins. Oil, R.			
Return Scrap				Good		Molasses			
Mchry. "				Bad		Parting Comp.			
Steel "				Gates, etc.		Plumbago			
Pile						Lake Sand			
Pile						Mold Sand			
TOTAL						Sea Coal			
						Soapstone			
						Wood			
Return Scrap				Good		Nails			
Mchry. "				Bad		1 Brick			
Steel "				Gates, etc.		2 "			
Pile						6 "			
Pile						Core Oil			
TOTAL						Brass Sand			

FIG. 2—FOUNDRY PRODUCTION REPORT SHEET FOR DETAILS OF THE DAILY MELT

PIG IRON RECORD

Kind of Iron _____ **Car No.** _____

Purchased From _____ **Pile No.** _____

Date Received _____ **Amount Rec'd** _____ **Cost** _____

Date	Used	Balance on hand	Date	Used	Balance on hand	Analysis	
						Silicon	
						Sulphur.	
						Phos.	
						Mang.	
						Comb. Carbon.	
						Graph. Carbon.	

FIG. 1—PIG IRON RECORD CARD

The Sociedad Espanola de Construccion Naval the advisory committee of which consists of the firms of Sir W. G. Armstrong Whitworth & Co., Vickers, Ltd., and John Brown & Co., England, recently purchased an electric furnace installation from the Electric Furnace Construction Co., Philadelphia, for use in manufacturing ferroalloys in Spain.

The West Side Foundry Co., Troy, N. Y., which several years ago took over the Paris Stove Foundry of that city, has been purchased by Thomas C. Perkins, Inc., investment bankers, of Hartford, Conn. The name of the company has been changed to the Troy Foundry & Machine Co., and additional capital has been provided for plant extensions.

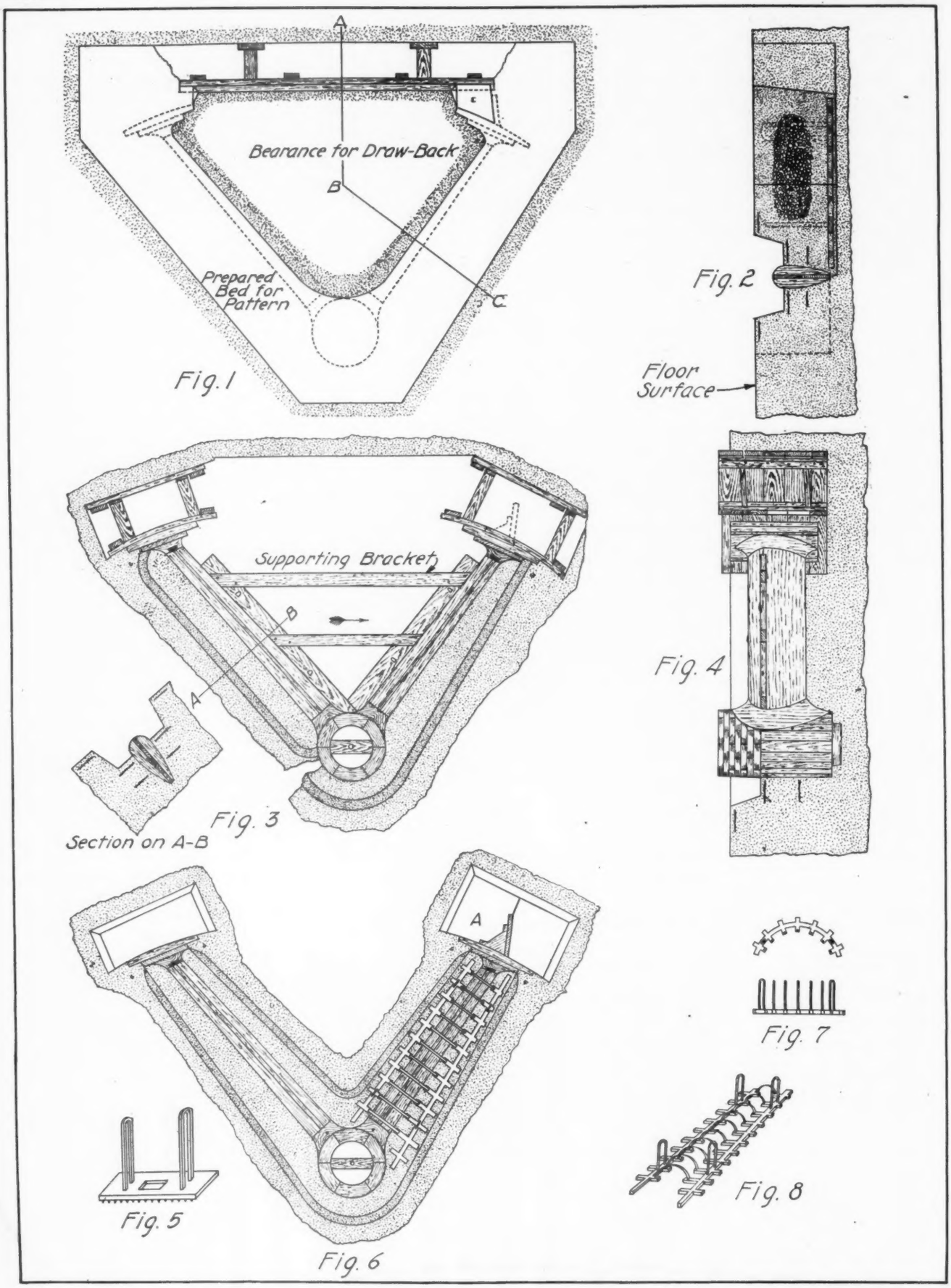


FIG. 1—PREPARATION OF MOLD FOR PROPELLER SHAFT BRACKET WHEN CENTER IS FORMED AS DRAWBACK FIG. 2—SECTION THROUGH *ABC* OF FIG. 1 RAMMED UP TO SHOW JOINT FIG. 3—ANOTHER METHOD OF MAKING MOLD, HAVING DRAWBACKS AGAINST PALMS AND SHOWING TWO FORMS OF JOINTING FIG. 4—ELEVATION OF MOLD IN DIRECTION OF ARROW IN FIG. 3 FIG. 5—PLATE SUITABLE FOR DRAWBACK FIG 6—READY TO FORM DRAWBACKS, SHOWING GRID IN POSITION FOR COVERING FIG. 7—GRID AROUND BOSS FIG. 8—GRID TO CARRY SAND OVER ARMS

Castings for Ship Construction—VIII

Unusual Care Must be Taken in Preparing Molds for Propeller Shaft Brackets to Insure the Proper Allowances for Contraction of the Metal — Large Flasks are Not Necessary

BY BEN SHAW AND JAMES EDGAR

SUCCESSFULLY preparing molds for propeller brackets requires considerable skill and taxes the ingenuity and initiative of the molder, not only in determining the most satisfactory means of forming the mold with the minimum amount of tackle, but also in recognizing the characteristics of the metal with which the mold is to be filled.

While the principles involved in the preparation of molds for all large steel castings are similar, the methods of their application often vary considerably. The methods adopted are usually determined by previous practice and the equipment and capacity of the foundry. This is equally true in the case of a propeller shaft bracket, and while the methods described may not be superior to any other, their use insures the production of good castings.

In preparing a mold for a bracket the central portion between the arms may be lifted in the form of a drawback, or the pattern may simply be bedded in, having drawbacks against each palm. In the former method, illustrated in Figs. 1 and 2, a bed is formed below the surface of the floor just sufficient to allow the shaft boss to project a small amount above the floor, when the arms are resting on the prepared bed. This bed should be perfectly level and an impression made upon it by lowering the pattern to ease out the sand from about the palms and boss, to allow the arms to come into contact with the bed. When the correct depth has been secured and the sand made up to the boss and palms, the positions of the arms upon the bed can be defined and on the removal of the pattern, a recess can be made to form a print for the drawback. The level of this recess can be carried out to the side of the hole dug in the floor and around one palm where a small drawback is required for convenience of access to the mold for the projecting rib. The position of this drawback is shown by *E*, Fig. 1. When the pattern is replaced a board can be set up, as shown in Fig. 1, to form the joint of the main drawback and preparation can be made to ram up the mold leaving the faces of the palms and the back of the drawback until the last operation.

If preferred, with the temporary bracket support fixed to maintain the arms in their correct relative position, the whole of the outside may be rammed up, and the joints prepared for both drawbacks. A grid is necessary for each of these, and care must be exercised in the design of the main to insure the necessary allowance for the contraction of the casting. When ramming up the inside and outside of this bracket, it is advisable to strengthen the sand by ramming in pieces of iron at right angles to the pattern and about ½-inch from it, placing them from 4 to 6 inches apart and in planes as shown in Fig. 2. With the palms projecting beyond the arms, some arrangement must be made to prevent the mold from acting against the force exerted by the casting when cooling. The length of the arms is reduced from 2 to 2¼ inches, providing the metal is free to contract. A good method for allowing for contraction is to ram up an old chain in the sand behind the palms and around the arms. The last link of each section is left accessible at the joint, so that a contact may be made through the cope in order to secure it to a crane for withdrawal. This is a simple device for loosening the sand at any part of the mold where it is desirable to relieve the casting.

Allowing for Contraction

In the construction of patterns for work of this kind contraction allowance is frequently made between the palms. This is not usually necessary. The ordinary standard measurement generally suffices because there is a tendency for the arms to open rather than close while cooling, depending very much on the rate of cooling at the boss.

The method of preparing the mold with drawbacks against each palm is preferable. It is advisable to prepare a bed in a manner similar to that just described and the bracket, shown in Fig. 3, should be used to firmly fix the arms in their relative positions. Joints must be formed for the drawbacks, and considerable taper can be given to the sides excepting those which come into contact with the palms. The joints at the back of these may be made after the pit has been dug, and the position of the pattern has been decided by trial. The pattern should be bedded in, so that the arms rest upon the prepared bed. The sand is rammed up around the boss, and the screws are removed from the fillet so that the withdrawal of the pattern may be facilitated. While ramming up, it is advisable to set in rows of pieces of iron beginning about every 10 inches from the bottom to bind the sand. Both sides are rammed until the pattern is firmly fixed in position and then preparations are made to form the joints for the drawbacks against the faces of the palms. A thin flexible board can be made to follow the contour of the faces, since the arc is usually very flat. This can be done by using boards similar to those shown in Figs. 3 and 4, one being set up against the prepared joint in each case, and the other being stayed up from it against the face. Sometimes a rough box is made to form the shape of the drawback, this being rammed to the joint of the mold, when it can be withdrawn and used for the other drawback. As soon as the pattern is firmly held the bracket between the arms can be removed, and the job finally rammed up. The molder must exercise care in removing all screws likely to interfere with the clean withdrawal of the pattern.

It is necessary at this juncture to form the joint of the mold. Two methods of satisfactorily accomplishing this are shown in Fig. 3. When the pattern for the barrel is made in one length, the joint may be dropped to the largest part of the arms and carried against the boss as shown, in order to strip the fillet. If, however, the boss pattern is jointed in a line with the thickest part of the arms, the joint of the mold may be carried round on the level as shown in Figs. 3 and 4. The section through *A B* shows the drop joint, a good flat bearance being necessary with a considerable taper on the sides. Fig. 4 and a section *A B* of Fig. 3 show the approximate positions of scrap iron which is inserted.

The projecting rib and one of the palms having been removed while preparing for the drawbacks can now be replaced and supported by two temporary brackets. One drawback would suffice against this palm but it is preferable to make two drawbacks at this

side, forming a joint at the extreme point of the projecting rib. Plates having staples cast into them, as shown in Fig. 5, suffice for carrying the drawbacks. The drawbacks are formed after the sides have been well coated with parting sand, by layering the bottoms with composite and bedding in the lifting plates. It is better to ram up the drawback behind the projecting rib—first, so that the use of the brackets may be retained until its correct position is determined. When this is accomplished the brackets may be removed and the rib allowed to rest flat up against the drawback formed. With all drawbacks rammed up and the joint made up to top of the palms, preparation should be made for covering. The recessed portion of the joint can be carried satisfactorily by means of grids fastened to the top box. Figs. 7 and 8 show the form of grids which fulfill the requirements. In Fig. 8 two grids are connected with a number of semicircular pieces of iron and being cast into the side grids they form a support to the sand surrounding the top of the arms. Two such grids carry the cope over the arms, and the small grid, shown in Fig. 7, connects the two about the boss. Fig. 6 illustrates the formation of the joint and shows the position of the drawbacks. One of the main grids is shown in position ,and it will be noted that the staples are cast in for convenience in fastening to the cope box.

Large steel foundries where ship castings are frequently made are equipped with a few large cope boxes capable of dealing with very large work. However they may be used to good advantage for work well within their capacity. In foundries where the melting capacity is large, but which do not have the equipment to deal with large cope boxes, a number of boxes may be used. In this case three cover boxes are used, carrying joints over the arms and near the boss. However, the grids must be rearranged so that three separate lifts can be made. The general method of carrying the top is as already indicated. It is better if the work can proceed without the delay of making special arrangements for a number of cover boxes. A form of cope box frequently in stock is shown in Fig. 9. In some foundries work of this character is molded inside of a large box bedded into the foundry floor, and the top flange is usually serrated with a number of slot holes.

In Fig. 9 the position of the gates and risers are shown, the risers being brought off the palms and the boss. Sometimes brackets of this kind are supplied with metal by way of the boss, and spray runners to the arms are used to supplement the supply of metal. The two gates shown supplying a spray can be formed to convey all the metal necessary, and two risers can then be drawn from the boss.

Before the cope box is placed in position, the grids should be bedded. The cover box is lowered, the grids secured, the runners and risers are set, and the sand rammed in place. Bits of piping should be placed over the ends of the chain sections, rammed up at the back of the palms in order to render them accessible when the job is finally closed.

While the cope is being formed the preparation of the cores should receive special consideration. A simple grid suitable for the arm cores is shown in Fig. 10. At two places and on an approximate line with the joint of the mold, two large pieces of iron are cast in the grid, projecting at each side far enough to penetrate the metal space, and having a sufficient bearance upon the joint of the mold to provide some support to the core, when setting it in its position. Two staples are provided for lifting purposes, and a couple of eye bolts project from the end of the grid far enough to pass into the center of the boss core. There are a number of methods of stiffening the arm cores, but as the only means of access after the job is cast is by way of the boss, a simple form of grid should be used so that the cleaning of the casting may be easily accomplished. The central portion of these arm cores should be filled with ashes, but the surface to a depth of about 3 inches should be sound and strong.

The patternshop must provide a sweeping board for the boss core. Usually in preparing cores for this kind, straw rope is worked about a horizontal spindle to within about 4 inches of the sweeping board, as shown in Fig. 11. Over the straw rope and at each end of the spindle are two circular grids, one having two long cast in staples. Long pieces of iron are firmly secured to each grid, forming a cage, which gives the necessary strength to the core. Stiff composite is worked in against the straw rope and surrounding the grid, and a

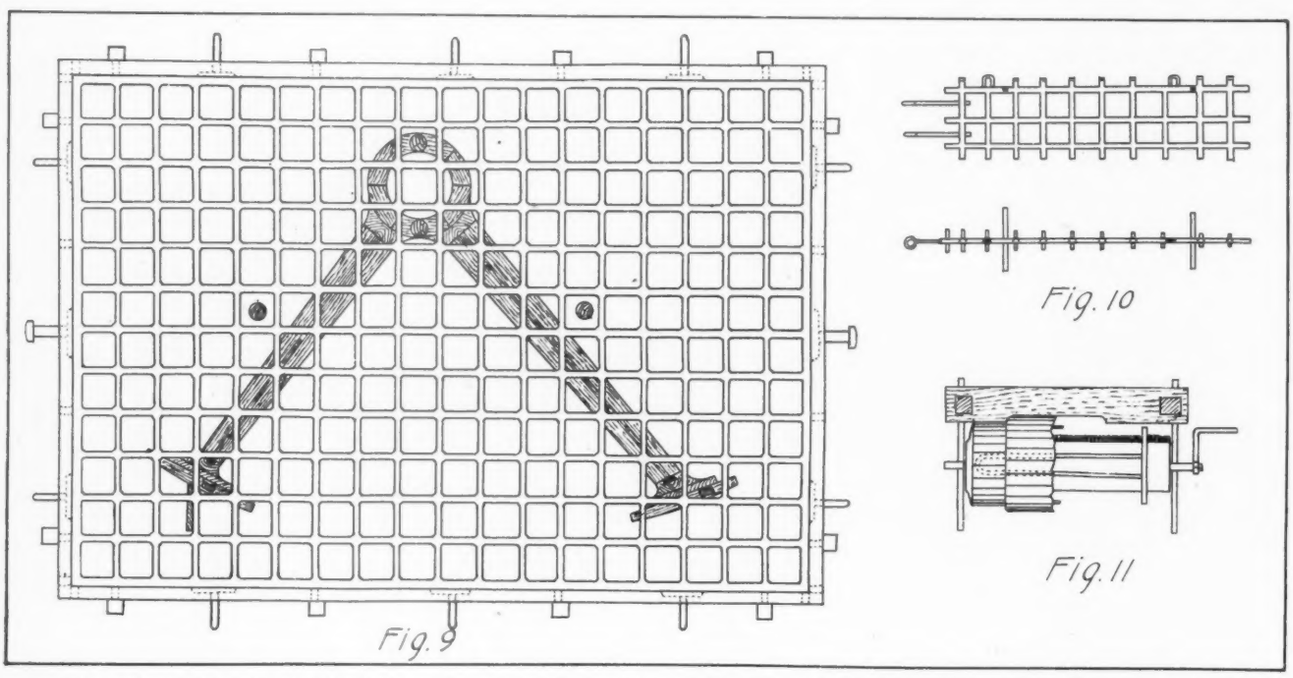


FIG. 9—COPE BOX SHOWING POSITION OF GATES AND RISERS FIG. 10—GRID SUITABLE FOR LIGHTENING CORE FIG. 11—METHOD OF PREPARING BARREL CORE

core is roughly turned up to within 1½ inches of the finished diameter. The core is then dried sufficiently to take the final coat of composite, which can be thinned down to give a better finish. When the cores are thoroughly dried, they should be coated with well boiled tar, and heated again until the tar is quite dry.

The cope box, having been sufficiently rammed to provide the necessary amount of covering and the gates and risers withdrawn, may be rolled over and the withdrawal of the pattern commenced. Care must be exercised in withdrawing the boss from the drag. Draw the fillets into the mold of the boss and thus clear the arms. The arms should not offer much resistance but screw eyes should be firmly fixed into them for convenience in handling. When these are removed, the drawbacks may be withdrawn, leaving the palms practically free. The runners should be prepared and the entire mold dressed up. A method of forming the spray runners is shown in Fig. 12. The approximate size of each inlet is 5 x 1¼ inches. A special mixture of composite is preferable for making up runners because the refractory nature of the sand must be maintained during the time of pouring. A method sometimes adopted for supplying metal to the boss is shown in Fig. 13, which is a section on *E F* of Fig. 12. Special steel runners are usually inserted when such a method is adopted. When the mold is well sleeked over, the sharp corners worked off, excepting around the palms where the corners are required to be square, and the joint of the mold compressed to cause a fin in the casting, the whole should be dried. The cope, having been treated in a similar manner, can be supported over the mold, and box fires

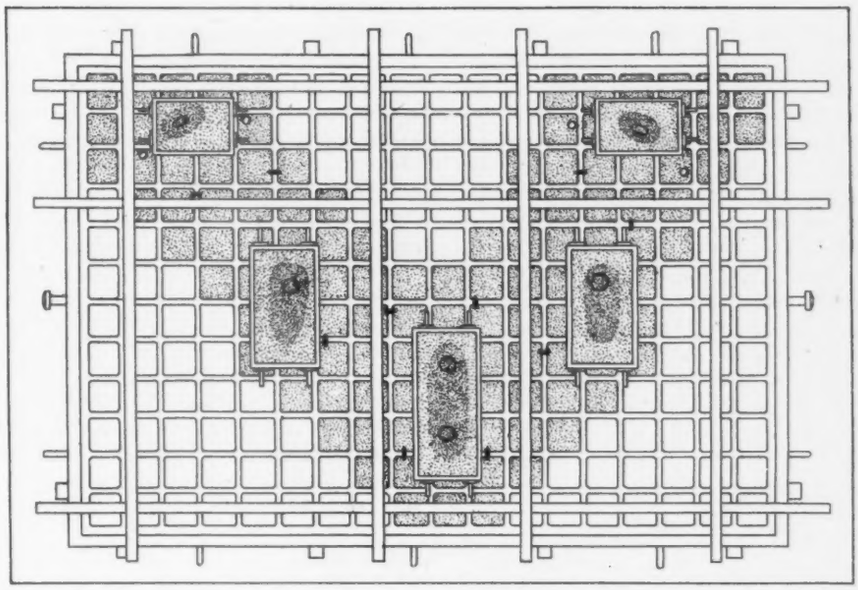


FIG. 15—PLAN OF MOLD PREPARED FOR CASTING

or mold driers used, the heat being retained as much as possible by sealing the sides with iron plates. When the mold is dry apply a coating of tar and again dry thoroughly. Sometimes only the mold about the boss is coated with tar, the arms being coated with silica paint. In heavy castings, however, well boiled tar is by far the best means of providing a good skin to the casting.

Assembling Mold and Cores

The mold and cores are now ready for assembling preparatory to casting. Lower the boss core in position and locate the approximate position of the arm cores. Withdraw the center core and proceed to cut clearance for the arm cores and to allow the eyebolts to pass through the wall of the core. Sink two specially prepared chaplet blocks into the bottom of each of the arms as shown in section *CD*, Fig. 12 and again place the center core in position. Set the arm cores in their relative positions easing out the sand on the joint to allow the irons cast in the grid to find a bearing when the cores are resting on the chaplets. Make a good butt-joint between the cores and wedge up inside the center core. If these cores are carefully handled they can be lifted as one and composite grouted in where they join and a small fillet formed. This must be thoroughly dried and coated with tar. Nail a few chaplets to the sides of the mold as shown in Fig. 12, and replace the cores when the job can be closed.

Clean the runner and riser gates, rub off any sharp corners likely to give way while the metal is passing through, and lower the cope into its position, using clay for testing the thickness over the

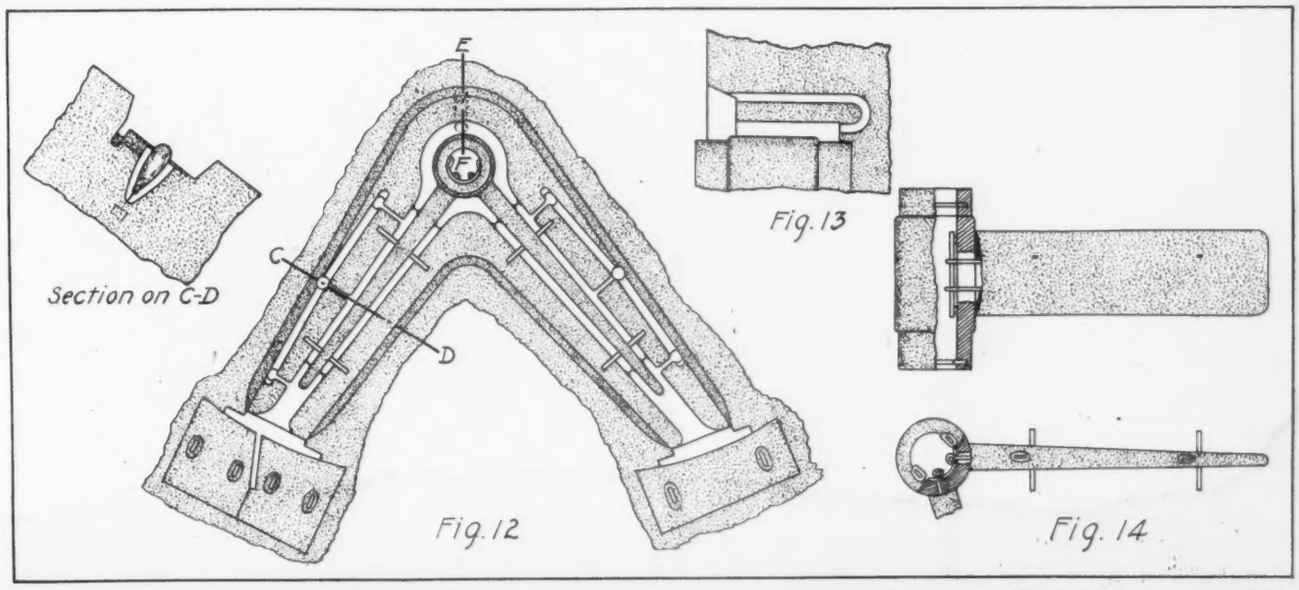


FIG. 12—MOLD ASSEMBLED READY FOR CLOSING FIG. 13—SECTION *EF* OF FIG. 12 SHOWING ALTERNATIVE METHOD OF RUNNING CASTINGS
FIG. 14—ELEVATION AND PLAN SHOWING METHOD OF SECURING CORES

arms. Try the runners and risers with chalk to be sure that their relative positions are maintained and then lift the top box for inspection. Set a few chaplets on the arm cores, their thickness coinciding with the thickness of clay. In order to cut off the possibility of metal finding entrance to the inside of the center core make a clay contact, oiling it well before finally lowering the cope. Attach hooks to the ends of the chain sections so that they can be easily secured to a crane when required to ease the casting.

The job may now be weighed and bolted preparatory to casting. The runner and riser basin may be made as shown in Fig. 15. It will be noted that only enough of the top box is used to provide the necessary covering. Two ladles of metal are necessary in pouring the job and stoppers are withdrawn simultaneously. It is advisable to feed the casting by way of the risers as long as the metal remains in a liquid condition. Within a little time of the cessation of feeding withdraw the chains and allow the casting to cool.

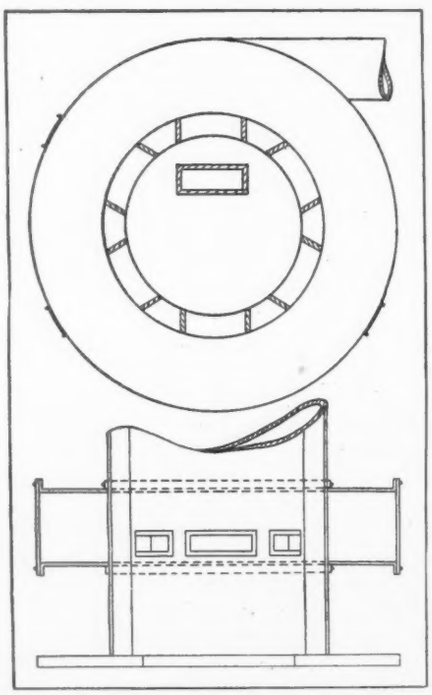
Castings of this description, because of their important position with regard to the propulsion of the ship must be of a reliable character and every care must be exercised in thoroughly annealing such castings. Providing the annealing furnace is prepared and its temperature is approximately that of the casting when it is put in, the casting may be transferred from the foundry floor to th furnace, while it is warm.

Design of Tuyeres for a Small Cupola

Question.—Does the nearly continuous tuyere for cupolas coincide with your ideas of a simple, practical, economical method of getting the air into a furnace? If this does not appeal to you what would you recommend for a 36-inch shell cupola? How do the volume and pressure of the blast operate when melting? Would you consider it advisable to have an air gage attached, and if so, what pressure should be carried?

Answer.—A cupola having a 36-inch shell and a single lining of bricks laid edgewise, has an inside diameter of 27 inches and an area of 572 square inches. It is considered fairly good practice to get 10 pounds of iron for every square inch of bottom area. In your case this would mean 5720 pounds, or nearly three tons. Approximately 30,000 cubic feet of air is required to melt one ton of iron; therefore, your problem resolves itself into providing facilities for introducing 90,000 cubic feet of air per hour into your cupola. The arrangement of tuyeres in the illustration which you forwarded is excellent but is rather elaborate for a small cupola. By consulting the literature of the different fan makers you will find that a centrifugal fan capable of delivering 90,000 cubic feet of air per hour will require a 15-horsepower motor to drive it, that it will run about 3000 revolutions per minute and that it will discharge through a 9-inch pipe.

Air must be introduced into the furnace according to certain established principles to attain efficiency. Experience has proved that it is volume of air and not pressure that counts. For instance, a large fan delivering 30,000 cubic feet of air in 10 minutes at a pressure of six ounces, would melt as much iron in that time as a smaller fan delivering the same amount of air in the same time but at 12 ounces pressure.



SIX TUYERES MAKE NEARLY ONE CONTINUOUS TUYERE

If getting a certain amount of air into the cupola was all that was required, a single tuyere would suffice. Here again experience steps in and proves that the air must enter the cupola uniformly from all sides if good melting is expected. There are various ways of accomplishing this purpose, depending on the size of the cupola.

The combined tuyere area should at least equal one-third of the bottom area. In your case that would mean 190 inches. Six tuyeres each 11 x 3 inches will have a combined area of 198 inches which is near enough for all practical purposes. The usual pressure for 36-inch cupolas is from 8 to 10 ounces. The accompanying sketch shows the general arrangement of a 36-inch furnace fitted up as outlined. These tuyeres require no elaborate pattern making; they offer no molding difficulties; they are easy to put in, in the first place, and it is quite easy to replace them when necessary. Furthermore, as there are only 4-inch spaces between them they make a practically continuous tuyere.

Six openings 11 x 3 inches each, equally spaced, are provided in the shell. The wind box is 12 x 12 inches and is riveted top and bottom to the shell with ½-inch rivets. The wind pipe is attached to the box tangentially. There are three peep holes, one opposite each alternate tuyere, and in addition, a section of the outside wall of the wind box about one foot long, is fastened with bolts instead of rivets. This is an emergency precaution in case the metal or slag reaches the wind box. By taking off this door any such obstacle can be removed without any further trouble.

History of Iron Founding Briefly Reviewed

Ironfounding is now such a commonplace operation that it is taken as a matter of course, but not many centuries have elapsed since a knowledge of how to make castings was a great secret. In 1720 the great French metallurgist, Reaumur, published an account of the methods then practiced by him. Previously, the pig iron had been melted in crucibles, but Reaumur conceived the idea of facilitating foundry operations by melting his metal in direct contact with the fuel, and the furnace he used may be regarded as the forerunner of the cupola. In 1747 the *Philosophical Transactions* of the Royal Society of London reviewed the art of making cast iron from pit coal and the method of making castings therefrom. This method had been practiced secretly at the foundry of Abraham Darby, Cotebrookdale, Eng. In 1707 he leased an iron works consisting of a single small furnace and foundry, located at Cotebrookdale, where he carried on his experiments. A young apprentice, John Thomas, observing the unsuccessful attempts of the workmen, thought he saw the reason for their failures. He was allowed to develop his theories, which proved to be correct. Mr. Darby made a secret agreement with his apprentice which was loyally kept. Simple as it now may appear, the knowledge of making such castings in iron was so limited at that time that the secret was not divulged for nearly a century. Later Abraham Darby's son substituted coke for charcoal.

How Research Work Brings Results

Experiments Undertaken Primarily to Develop Control System for Electric Furnaces Brought Surprising Benefits in Unexpected Directions — Research Department May Have Special Value in Foundry Work

BY H. E. DILLER

IN the dark ages, a few centuries ago, no one rode on railroad trains or trolley cars, neither did people talk to each other over the telephone or fly in airplanes. There are a great many other conveniences of modern life which were not available to the people of those days. But there was absolutely nothing to prevent the utilization then of all the conveniences now at the disposal of the average person, except lack of knowledge. Everything else was at hand as much then as it is now.

Knowledge in chemical and mechanical fields was acquired slowly. In the early days the alchemist worked in solitary seclusion to wrest the secrets of life from the elements —earth, air, fire and water. Gradually it came to light that these four essentials were not elements, and eventually the atomic theory was evolved. Science proceeded on the assumption that there was an atom which was the smallest particle of matter and could not be further divided. Then recently the discovery was made that the atom is not what it was thought to be, but that it is made up of many particles which have been named ions.

How soon the ion will be found to be something different from what it is now supposed to be, it is impossible to say. But it is clear that while the theory of matter has been developing, many useful inventions have resulted. And now instead of the solitary alchemist, research workers in many fields are banded together to solve industrial problems, supported by great combinations of capital and with large and highly developed laboratories at their disposal.

With his inventions protected by letters patent, the research expert has been found to be a paying investment for the progressive manufacturing company. One of the large corporations which has obtained worth-while results from research work is the General Electric Co., Schenectady, N. Y. Its success in this field is largely due to the broad, free policy which has been adopted in connection with the work. Large research laboratories are connected with nearly all the company's principal works, but the research work is not confined to these laboratories and sometimes there are three or four departments in the same works carrying out investigations.

The main general research laboratory of the company is at Schenectady under the direction of Dr. W. R. Whitney. While always ready with helpful counsel when it is requested or specially needed, Dr. Whitney's policy is to allow freedom to the individual worker, to encourage him and avert discouragement.

When a line of research is started no one knows what it will bring forth, because frequently a certain line of research has been started and before it has been finished something entirely unthought of in the beginning has resulted. For this reason a broad general field is taken up with the conviction that some of the lines in the particular field will lead to profitable inventions and pay for other experiments which fail in obtaining results.

FIG. 1—RESISTANCE-TYPE ELECTRIC FURNACE USED TO MAKE FERROTITANIUM

Before 1909 enough research work in the electric furnace domain had been carried on at the Schenectady works to cause the company to believe extensive experiments would bring results. Therefore a concrete building, 75 feet wide by 165 feet long, was built to be devoted to electric furnace work. This building was opened in August, 1909. It is divided lengthwise into two bays each of which is served with a 7-ton crane. The transformers are located on a concrete platform in the center, enclosed to protect them from dust. The transformer cages are seen at the upper left-hand corner of Fig. 2, which shows one of the bays of the building.

A small chemical laboratory was installed in one corner of the furnace house so that analyses of metal could be made quickly. Frequently it was necessary to know the composition of the metal in the furnace before tapping it. In such cases a laboratory conveniently situated was indispensable. When an experimental heat is made, the full benefit of the work is not obtained unless the action and results are studied from all points of view. In order to do this, not only was the small laboratory in the furnace-house of use but the numerous physical, chemical and electrical laboratories at the Schenectady works were called upon. Incidentally this is one advantage a large company has in doing research work: It already has many of the requisite facilities which would be almost prohibitive in cost were it necessary to establish them specially for research work. Some of the additional advantages enjoyed by a big concern are that it has a variety of shop facilities, and a large personnel of mechanics and engineers who are available at all times to aid the experimental work in many ways.

Having a number of shops with a diversified output, a great corporation has many problems coming up continually for settlement by experimentation. It also has an outlet for the products of the research department. How this works out with the General Electric Co. will be seen as the different steps in the progress of the furnace-house work are shown.

The first thing produced in the furnace-house was titanium carbide. This was made in a resistance furnace shown in Fig. 1, in which the heat is developed by resistance to the electric current. Beside this furnace two direct-arc electric furnaces, Fig. 4, were installed. In them heats as small as 200 pounds or as much as 800 pounds could be made. They thus gave opportunity for experiments in making up alloys and different steels without the expense of a large charge each time and, were splendid tools for the metallurgist.

FIG. 3—ELECTRODE MOTOR—NOTE HOW THOROUGHLY INCASED IT IS

These small furnaces, while being well adapted for experiments, were entirely hand operated and so did not give opportunity for the main points of development desired by the company, which included designing suitable motors to tilt the furnace and to raise and lower the electrodes, and to design a control system which would regulate the arcs. Therefore a larger furnace of 2 tons capacity, Fig. 6, was built. It was designed so that the electrodes could be raised or lowered to regulate the arc, either by hand control or by automatic control of the motors.

After this furnace was ready to operate, a molder came over from the gray-iron foundry and with his help, and advice from the foundry superintendent, the crew in the research department, none of whom had ever worked on a steel furnace or in a steel foundry, started to make steel castings. There was some excitement at first, especially at pouring time when there happened to be a leaky ladle nozzle. But the work was so successful that in a short time the experience gained from operating this furnace caused the company to decide to put the furnace into regular production and it was transferred to a section of the gray-iron foundry and put under the direction of the foundry superintendent. The laboratory transferred one of its men to act as melter, and supervised the operation of the furnace until everything was working smoothly. This move was justified by the fact that from the first small and complicated steel castings were made cheaper in the electric furnace than they could have been purchased at that time. An even greater advantage was that castings could be made on short notice, avoiding the delay occasioned by ordering castings from outside firms.

When this 2-ton furnace became well established on a productive basis

FIG. 2—EXPERIMENTAL FERROSILICON FURNACE—ONE BAY OF THE FURNACE HOUSE IS SHOWN

FORMULAS FOR THE BRASS FOUNDRYMAN

Fluxes for Nonerrous Metals

Fluxes for Lead

The following flux is used in lead refining:

	Parts
Caustic soda	3
Roll sulphur	1

Mix together and add to the molten lead heated to 400 or 500 degrees Cent. allow the flux to act for a short time, then skim off. Another way of preparing the same flux is as follows:

	Parts
Caustic soda	50
Sodium hyposulphite	50

Mix and use in the same manner as the former flux.

Flux for Bell Metals

	Pounds
Soda ash	30
White sand	30
Borax (calcined)	10
Yellow prussiate of potash	30

Use 1 per cent, added when the alloy begins to get molten in the case of a remelt, and just before the tin is added in the case of new metals.

Flux for Grindings

	Pounds
Soda ash	25
Salt	25
Plaster of Paris	25
Fine charcoal	25

Mix 10 per cent of the flux with the grindings, and melt together in a hot furnace. Ingot both the metal and the liquid flux, and when the melt has cooled, break away the slag with a hammer.

Ordinary Flux for all Kinds of Brass

	Pounds
Powdered glass	80
Calcined borax	10
Fine charcoal	10

Add sufficient to form a liquid film of slag over the molten metal and thus protect it from the oxidizing effects of the furnace gases.

FORMULAS FOR THE FOUNDRYMAN

Melting Points of Solders

Lead and Tin Alloys

The melting point of lead and tin alloys and the hardness by the Brinell method are as follows:

Tin per cent	Lead per cent	Melting Point, degrees Fahr.	Hardness Brinell method
0	100	618.8	3.90
10	90	577.4	10.40
20	80	532.4	12.16
30	70	491.0	14.50
40	60	446.0	15.80
50	50	401.0	15.00
60	40	368.6	14.60
66	34	356.0	16.70
70	30	365.0	15.80
80	20	388.4	15.20
90	10	419.0	13.30
100	0	466.0	4.10

The hardest alloy, it will be noted contains 66 per cent tin and 34 per cent lead, which is practically the eutectic alloy and has the lowest melting point.

Hard Solders

The melting points of the copper and zinc alloys follow:

Copper per cent	Zinc per cent	Melting point degrees Fahr.
100	0	1980
96	4	1967
86	14	1890
80	20	1846
76	24	1796
72	28	1756
71	29	1746
66.4	33.6	1684
63	37	1666
60	40	1634
50	50	1616
48	52	1598
41	59	1544
35	65	1501
33	67	1477
29	71	1467
24	76	1364
20	80	1301

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

THE FOUNDRY DATA SHEET, AUGUST 15, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

FIG. 4—TWO 800-POUND CAPACITY FURNACES—THE FIRST INSTALLED FOR STEEL MAKING

the demand for castings became so great that a 5-ton furnace was installed. More recently 6-ton furnaces have been put in operation at the company's works at West Lynn, Mass., Pittsfield, Mass., and Erie, Pa. A view of the Erie furnace is shown in Fig. 8.

When the first 2-ton furnace was transferred to the foundry another one was built for the research department embodying new features suggested by the experience with the first furnace. In this new furnace, Fig. 7, an attempt was made to produce carbon tool steel. Success attended these experiments from the start. Then it was decided to try a heat of high-speed tool steel and an encouraging account of the first heat was received from the machine shop which reported it to be as good as the steel being purchased from tool steel companies. Backed by this report more heats of high-speed steel were made and extensive machining tests were carried on to determine what one of the many compositions used gave the best tool steel.

The 2-ton furnace was also used to make about 50 tons of 3.5 per cent silicon steel. Such steel is used in transformers on account of its low hysteresis loss and engineers of the com-

FIG. 5—FURNACES DESIGNED AFTER EXPERIMENTING WITH FURNACES SHOWN IN FIG. 4

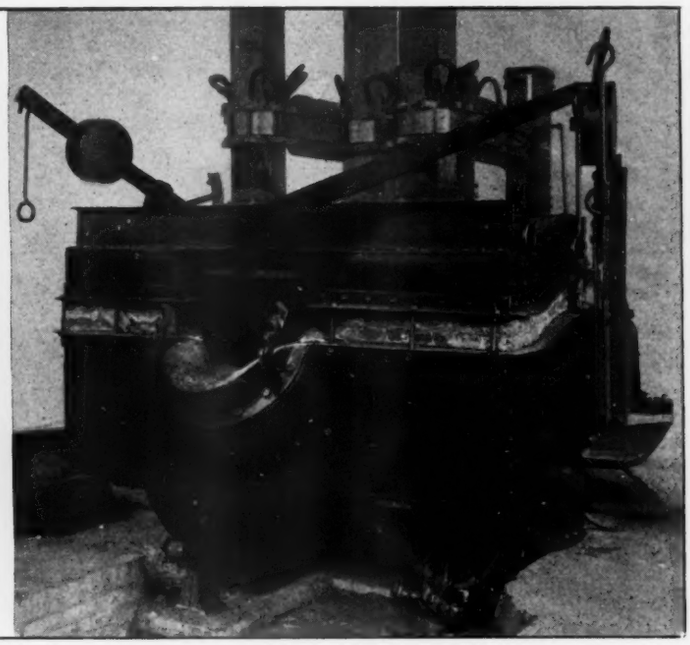
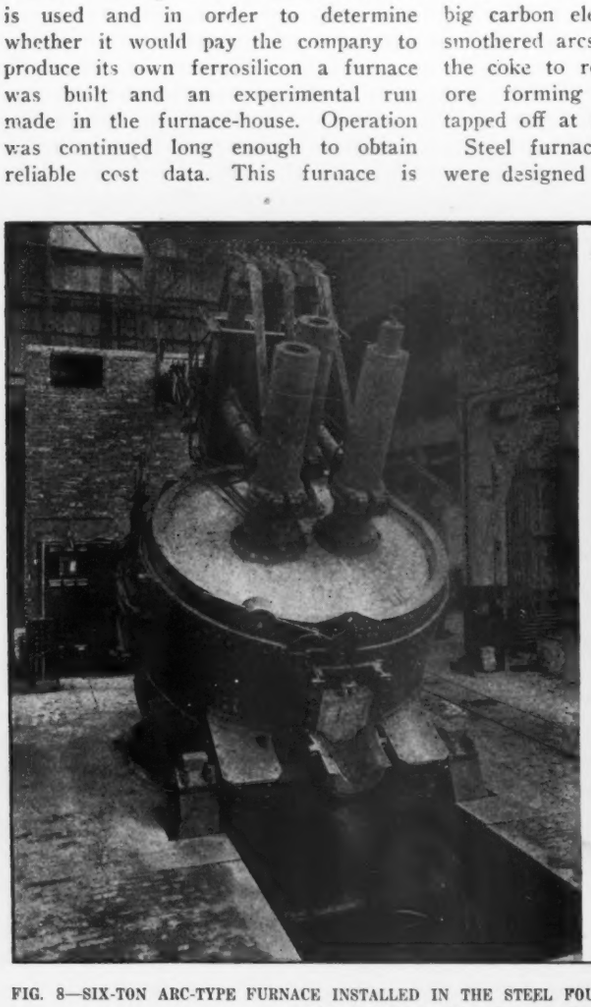


FIG. 6—ORIGINAL INSTALLATION OF THE 3-PHASE 2-TON ARC FURNACE FIG. 7—THE SECOND 2-TON FURNACE DESIGNED—NOTE CHANGE IN TILTING DEVICE—FURNACE HAS BEEN PUT ON ROLLERS

pany wanted to find out whether there were any advantages to be gained by making it in the electric furnace.

In the manufacture of this high-silicon steel a large amount of ferrosilicon is used and in order to determine whether it would pay the company to produce its own ferrosilicon a furnace was built and an experimental run made in the furnace-house. Operation was continued long enough to obtain reliable cost data. This furnace is shown in Fig. 2. It consisted of a steel tank, elliptical in cross-section, lined with fire brick. In this was put a mixture of coke, iron ore and quartz which was filled up around the two big carbon electrodes. Heat from the smothered arcs of the electrodes caused the coke to reduce the silica and iron ore forming ferrosilicon. This was tapped off at intervals of six hours.

Steel furnaces of 800-pound capacity were designed for production use in the foundry. They were based on the small furnaces shown in Fig. 4. A few improvements were made in them as can be seen in Fig. 5. It will be noted that the body, instead of being made of castings, is made of steel plate tied together with angle iron. Heavy, square carbon electrodes have been replaced with round ones. It was always necessary to throw away the ends of the square electrodes when they were burned short, but a different electrode



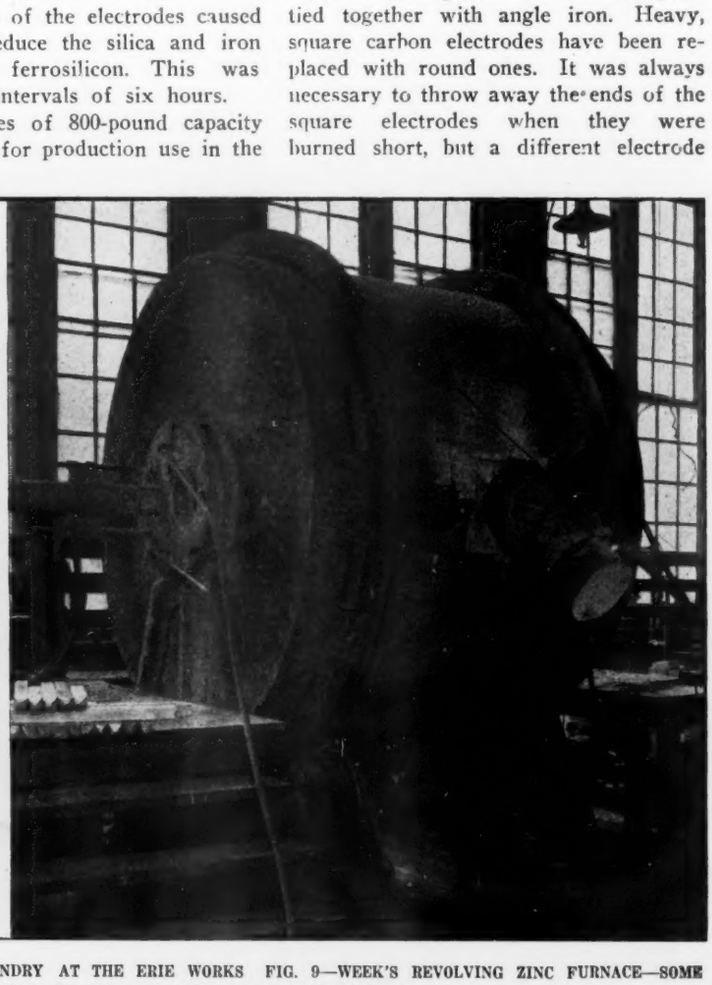


FIG. 8—SIX-TON ARC-TYPE FURNACE INSTALLED IN THE STEEL FOUNDRY AT THE ERIE WORKS FIG. 9—WEEK'S REVOLVING ZINC FURNACE—SOME BARS OF ZINC MADE IN THE FURNACE IN 1910 ARE SHOWN ON THE PLATFORM

holder has been designed for the new furnace and the electrodes are so made that one can be screwed into the holder and another section screwed onto it. In this way the electrode can be used until too short to be of further service. Then a new section can be screwed into the holder and the remainder of the old section screwed into it, so that the entire electrode can be used and there is no waste.

These furnaces are used for making various ferroalloys. One interesting application is the making of resistance grids from gray-iron scrap containing a small percentage of aluminum. The grids are originally made from iron melted in the cupola, to which the proper amount of aluminum is added in the ladle. But it is impossible to remelt the gates and risers in the cupola without burning out all the aluminum. To prevent this excessive loss the scrap is melted in the small electric furnace where the loss is from 5 to 10 per cent of the aluminum. After the iron is melted a grid is cast, cooled from a dull red heat in water and measured for resistance. When its resistance is known the right amount of aluminum it is necessary to add in order to make the iron of the proper specific resistance can be calculated from prepared tables.

Beside experimenting with different kinds of steel, iron and ferroalloys, experiments have been made with zinc, copper and nonferrous alloys. One day a heat of copper was very successfully melted in the 2-ton arc-type furnace. The only drawback to complete success was that the next day all the men who had worked at the heat were at home sick. This did not discourage research work along the line of melting the more volatile alloys in an electric furnace. Instead the work was continued in this field until the electric brass melting furnace, described in THE FOUNDRY of May 15 and June 1, was evolved by the company.

Experiments were made in 1909 and 1910 on smelting zinc in an indirect-arc furnace, Fig. 9, invented by Charles A. Weeks, Philadelphia. This furnace was also used for melting copper. Some years later the principle of this furnace was used by the United States bureau of mines where, under the direction of H. W. Gillett, a rocking electric furnace for melting brass was developed based on the furnace designed by Mr. Weeks. The rocking electric furnace is now being put on the market by the Detroit Electric Furnace Co., Detroit.

All the foregoing work while of great importance to the company was only secondary to the design of motors and automatic control for the furnaces. Years of experimental work on furnaces in actual operation were necessary to develop this apparatus to the point it now has reached.

As at present designed there are two panels used to operate the control system. These panels are shown in Fig. 10. The double-throw switch, *C*, panel *A* is thrown one way when it is desired to run the furnace by hand control and is thrown the opposite way when it is desired to operate with automatic control. The three double push-button switches, *D*, are used for hand control. The four switches, *E*, throw the current into the electrode-motor circuits; one switch connects with the main line and each of the other three switches connect with one of the three electrodes. At *F* are the contact-making ammeters, each of which is connected to one of the electrode circuits with a current transformer. Adjustment of them is made by means of the calibration springs shown at *G*. By this adjustment they are so fixed that when the current going through any electrode gets below any given amount, the switch to the right at one of the sets, *H*, will close and cause the motor to lower the electrode at the particular arc. Conversely when the current at any electrode is too strong the switch to the left at one of the sets, *H*, will close and raise the proper electrode. Contactors for cutting out resistance on the electrode motors are at the top of the panel at *I*. This resistance is cut out so the motors will run at higher speed when hand control is being used.

The Dayton Malleable Iron Co., Ironton, O., has prepared plans for a new core room. The present core room will be used to furnish additional wood and metal pattern-making facilities.

Aluminum Cylinders Being Perfected

Question:—When aluminum cylinders are used in automobile motors, what is done to prevent excessive wear on the bore of the cylinder by the piston rings?

Answer:—Aluminum cylinders are not at present used to any great extent in automobiles. One company we understand is using an aluminum cylinder with cast-iron sleeves in the cylinder bore. Other companies are experimenting with electroplating the bore with a coating of iron and then heat-treating the casting. In other cases the plated surface is put on in such a condition that heat treatment is not necessary. While considerable success has been attained in plating the bore with iron none of the processes have yet been far enough perfected to warrant any company in adopting an aluminum cylinder with a plated bore for its automobile. As aluminum radiates heat several times faster than cast iron the use of aluminum cylinders would be a big advantage in this respect, especially in air-cooled motors and it is understood that such cylinders are now being tried out in a few cars.

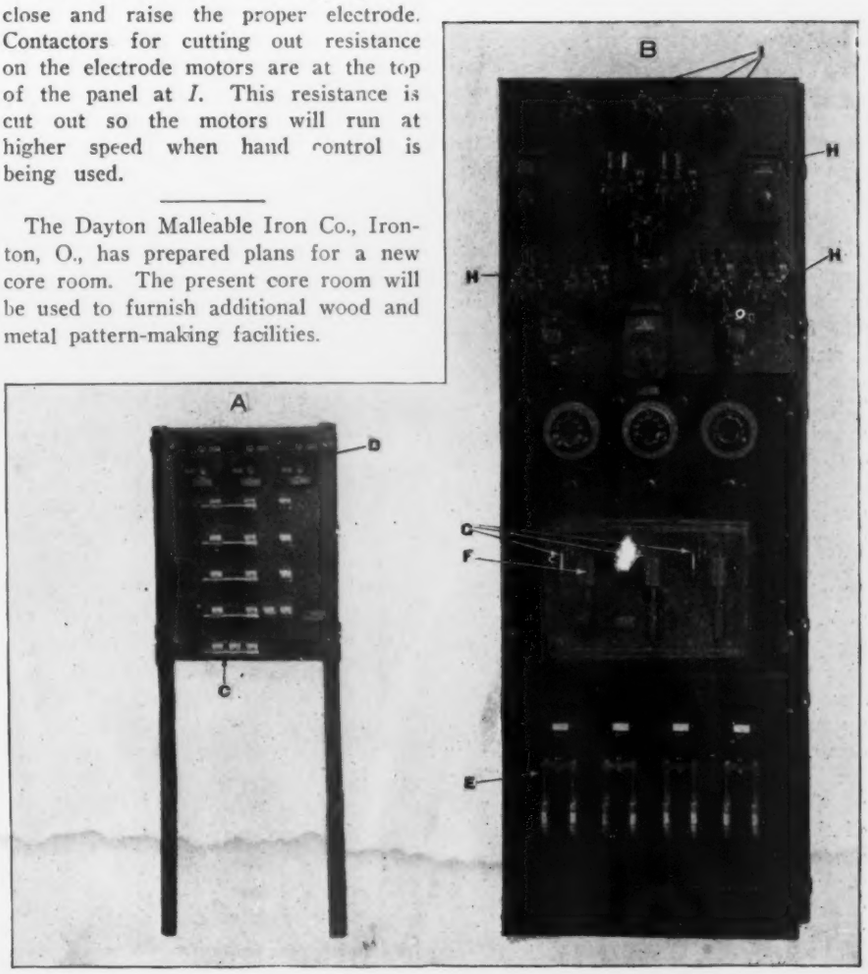


FIG. 10—CONTROL PANELS FOR OPERATING THE ELECTRODES

Problems in Small Foundry Design

Many Minor Points Are to be Considered—Water Supply Should be Handy for the Molders Use—Different Ways of Preparing the Floor—Cupola is Most Important Consideration

BY M. H. POTTER

IN considering construction of a building the question whether the structure shall be of wood, brick, stone, or steel, or a combination of all these materials depends nearly always on the amount of money available. But whatever type of structure is adopted, it must be wind and waterproof. In the case of foundries, it is of the utmost importance that molds be protected from rain and frost; on the other hand an atmosphere which is too dry is as troublesome to some green-sand molders as excessive cold and dampness. If all green-sand molding could be carried on under a uniform temperature of about 50 to 60 degrees Fahr., the advantages arising from such a condition, in the writer's opinion, would more than meet the outlay attending the heating of foundries in winter. Again the cost of an adequate ventilating system during the summer months would more than pay for itself in increased production. It is an undoubted fact that the better the conditions under which men work in the foundry, other things being equal, the greater are the profits of the employer.

Why Foundries Need Water

An adequate supply of water is necessary for tempering the sand after castings have been taken from the floor, and for other uses about the foundry. Water, at even the cheapest possible rate, totals up quite a monthly bill. The advantage of building a small foundry near a running stream is quite obvious; provided, however, that the foundry floor is high enough above the stream to obviate any danger of the water seeping in.

Fig. 1 shows the ground plan of a foundry, 40 feet in length and 30 feet wide, which should give ample room for a production of five or six tons of jobbing castings per week. This output is computed on the basis of alternate day melts, but it may be considerably increased by casting daily. In Fig. 1 the derrick crane is shown clearly. The cupola is let inward through the wall of the foundry. Fig. 1 also shows the core oven, together with the core room, the shelving for core-boxes and patterns, the building columns, the molding-tub, the blacksmith and dressing shop, and the storeroom. Irrespective of the class of material selected for construction, the best plan is to begin by setting the columns on concrete foundations at suitable intervals to insure safety in carrying the roof. In steel frame buildings lattice columns are used with suitable brackets attached for supporting the rails of the traveling crane.

To a practical molder the preparation of the foundry floor would not present any particular difficulty, he would simply clear out the bottom to the depth required and thus prepare it for the floor sand. The question of the cost and quality of molding sand, however, is an important one when starting a new foundry. The distinctive qualities for practical molding are plasticity and porosity.

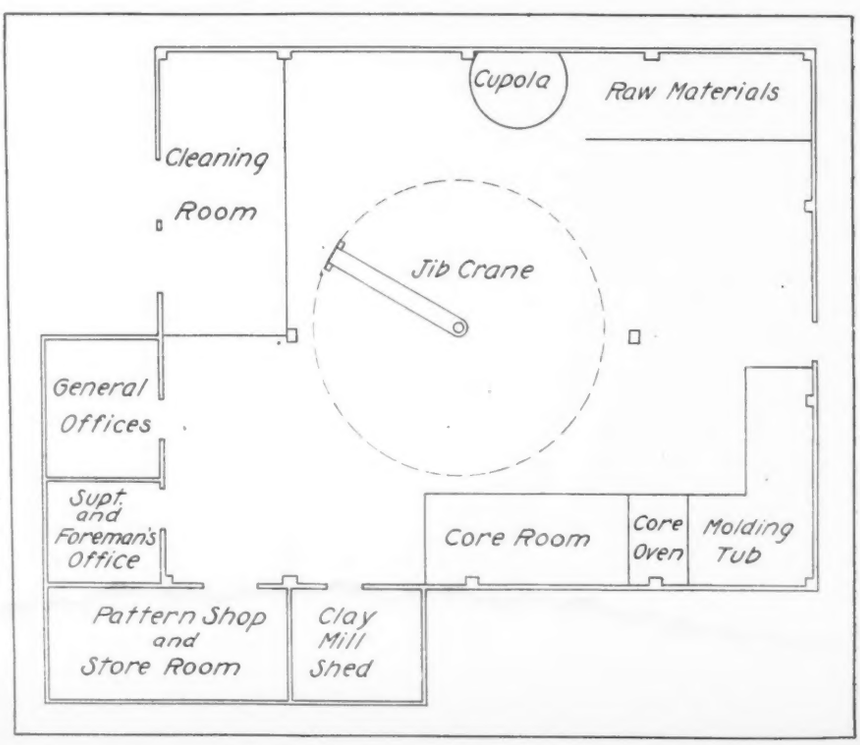
Under ordinary circumstances a bed of sand 9 to 12 inches in thickness is sufficient. Should a greater depth be required for special work it is only a matter of digging, additional sand being added from time to time as required for such work. This is a good method of forming a floor for a small foundry. In the case of a foundry anticipating doing heavy work, however, the depth of the sand floor would depend on the size and shape of the work which would have to be handled.

A derrick with a lifting capacity of two or three tons should, in a general way, do all that is required. In the matter of flasks, everything depends upon the nature of the shop and work to be done in it. Metal flasks are now used extensively.

Importance of Securing Right Type of Cupola

The cupola is the backbone of the foundry. If it does not work satisfactorily no foundry can operate on a paying basis. The ideal furnace is one which combines simplicity of design with an ability to melt the most iron at the least cost. In purchasing a cupola it is well to exercise caution, go slowly, and deal with established firms that have a reputation for building satisfactory cupolas. In contracting for a cupola it should be specified that the furnace be capable of melting and delivering iron at the proper temperature for pouring any kind of jobbing work.

The actual making of the molds is a matter of shop practice which requires considerable care and depends a great deal on discipline and organization. The foreman should be a thoroughly practical foundryman able to direct men.



LAY-OUT OF A SMALL, GENERAL JOBBING SHOP

Insure the Integrity of Malleable

Soundness of Metal in Castings is Secured by Eliminating Chills and Strict Adherence to the Use of Feeding Heads to Furnish Metal at Proper Pressure

BY ENRIQUE TOUCEDA

THE writer can thnk of no subject of more vital interest to the manufacturer of malleable iron castings or one to which for his own welfare he should pay more strict heed than the integrity of the castings.

While many of the problems in connection with the metallurgy of the process have now been solved and we know with certainty the conditions that should obtain to produce regularly such a character of hard iron that when annealed it will yield metal of superior strength and ductility, as well as all details of heat treatment that will uniformly produce best results, failure on the part of some to make sure at all times that castings are invariably sound throughout remains the one deep-seated canker which if not cured bids fair to eat into the vitals of the industry.

It is not to be inferred that the malleable iron casting is unique in this particular, because the statement just made can be applied with even greater force to both steel and to nonferrous castings generally, especially in regard to blow holes of significant size and to internal strains, from both of which difficulties the malleable casting is exceptionally free. When unsoundness does exist it usually arises and has to do mainly with the character of porosity resulting from disproportionate sections in the casting which manifests itself as a rule, never in blow holes, as such arise from other causes, nor in voids of any size, but in a more or less sponginess which weakens the section at its location.

There is great and unquestionable value derived from the physical tests of each air furnace heat for it is through such tests alone that the manufacturer can be assured as well as prove to the purchaser's inspector that up to and through the annealing process he has produced exactly what was sought; but this is as far as it goes, for the latter is not buying test bars, nor are these being used commercially. In what has preceded it has been implied that the majority of the producers of these castings are in a position to guarantee positively both the quality and uniformity of their product when measured by physical tests on test-bars from each heat. That this is true the writer can state unqualifiedly, while in the case of a more or less limited number a similar statement in regard to the integrity of their castings can be made with equal force and assurance; that he is forced to make this particular qualification is exactly what has occasioned the choice of this topic by the writer.

It is more satisfactory always to be specific and to furnish data where such is possible. With this object in view I subjoin figures showing the combined monthly average ultimate strength and elongation of some 32 different concerns covering May, June and July, the data being gathered from many hundreds of tests made during each month.

May

Average ultimate strength, lbs. per square inch. 50171
Average elongation, per cent 10.78

June

Average ultimate strength, lbs. per square inch. 50235
Average elongation, per cent 11.14

July

Average ultimate strength, lbs. per square inch. 50715
Average elongation, per cent 11.59

The above data should furnish justification for what has been stated as to the ability of many makers to produce with constancy a metal of superior strength and ductility, even under the handicap of inability, due to present stress, to make use of as good a quality of pig iron and fuel as are necessary for best production. Also, in looking over these records it is only fair to consider that included in them are bars from concerns in which high strength and ductility have been sacrificed to secure such a character of metal as would machine with the greatest ease, this property in these particular cases being the predominating requirement.

To illustrate what is possible of accomplishment there is recorded herewith a run of 24 successive heats, the bars having been received in three batches, the first consisting of 12, the second of six and third of six.

First Lot of Twelve

Average ultimate strength, lbs. 58493
Average elongation, per cent 22.91

In this lot one bar had an elongation of 29.00 per cent and another of 27.00 per cent.

Second Lot of Six

Average ultimate strength, lbs. 58033
Average elongation, per cent 18.12

One bar in this set had only an elongation of 9.50 per cent, this lowering the average considerably.

Third Lot of Six

Average ultimate strength, lbs. 57371
Average elongation, per cent 23.83

One bar in this set stood 30 per cent elongation.

The average ultimate strength of the 24 bars is 57,969 pounds per square inch, and the average elongation of the 24 bars is 21.62 per cent. If the manufacturer has been able to arrive at such a point of excellence where he can positively guarantee that the test bars from each and every heat will meet rigid and exacting requirements it is pertinent to inquire why in the case of many have they been so dilatory in connection with proper molding methods.

The writer is going to make an attempt to answer this inquiry correctly and to place the blame where it belongs. It is safe to assume that in the early days of the industry the malleable iron casting that was solid throughout was the exception. Lack of solidity, as already inferred, was not due to the presence of blow holes but was the result of failure on the part of the founder to recognize the fact that in castings of disproportionate sections, and by far most malleable iron castings are of this character, the thinner sections solidifying more quickly than the heavier ones to which they are attached would draw the metal from these still fluid parts before they in turn were able to secure their full quota of metal from the risers.

This state of affairs I presume was productive of so many failures that efforts were concentrated to better these conditions, first, presumably by varying the position and size of gates and risers, etc., but finally by some

From a paper presented at the annual meeting of the American Foundrymen's association, Milwaukee, Oct. 7-11, 1918. The author, Enrique Touceda, is a consulting engineer of Albany, N. Y.

bright mind determining that the cause of the trouble was fundamentally due to the difference in the rate of cooling of thin and thick parts. Once this conclusion had been reached it is easy to see that the use of the chills to equalize cooling was the natural and obvious outcome.

It was then perhaps found that while under the arrangement of gates and risers used the chill could not equalize the cooling sufficiently in the majority of cases to make heavy parts perfectly sound it did serve both to lessen the unsoundness, or shrink as it is called, and to drive it from a place where its existence meant scrap to a locality much less harmful.

While not positive, I feel quite sure that the use of the chill originated with the malleable iron founder. Be this as it may, its use in the early days, while an important step in advance, has since operated to deter progress along the lines of soundness to a greater extent than has any other agency, for the reason that the founder has remained content to adhere to this as a palliative rather than seek after the real cure. There has been a continual effort on his part to shift the boil on the end of his nose to some place on his body where it will be both hidden from sight and less painfully located instead of taking proper and effective steps to eradicate the cause.

Aside from cases of intricate and improper design in which it is practically impossible to properly feed the casting the chill has been baneful in its influence and a curse. As already stated there are now a large number of founders who are able to guarantee that the physical properties of their castings will square with that of the test bar. Such, for the most part, have discontinued the use of the chill and are so feeding their castings by means of large reservoirs of metal that soundness results and shrink is absent. These concerns have made a thorough study of molding principles; gates and runners are properly proportioned and properly set; also the pressure of metal entering the mold is so regulated by the height of the reservoir above the highest point the metal attains in the mold that by virtue of this pressure or head, coupled with the mass of metal in the reservoir, the feeding of all sections, light or heavy, continues until solidification is completed.

With these concerns the day of the chill has passed, and while a few must use it from time to time in extreme cases, even this will cease soon as the designer awakens to the fact that slight alterations in his design will render their use unnecessary.

Our opportunity is at hand because it has at last been demonstrated beyond a shadow of doubt that the most complicated malleable castings can be regularly produced by many concerns without a trace of shrink, and of a strength and ductility not thought possible some years ago. The engineer now knows this to be the case and knows as well that we have outgrown and made up for past misdemeanors. Discard the chill and in its place substitute risers or heads of such height and section as will furnish sufficient pressure of fluid metal to make sure the casting's integrity.

Have some one on the job who understands this art and keep him busy with every pattern that needs attention. Impress him with the thought that he is the most important man in the place, which under conditions now existing is the case, and hold him responsible for any lapse in the direction of unsoundness.

In breaking hard iron castings in search for shrinks do not assume that none are present until those thought solid have been annealed, because this treatment will develop a shrink not discernible prior to annealing.

In the malleable industry a new era has dawned, a fact frankly admitted and acknowledged by the trade. Let us stand shoulder to shoulder for mutual help in the matter of soundness. Let the integrity of the casting be the first consideration, for a solid casting made of ductile metal having an ultimate strength of but 40,000 pounds per square inch is unquestionably superior to one in which shrink is present though the test bars in the latter case yield an ultimate strength of 50,000 pounds per square inch and an elongation of 20 per cent.

A new zinc alloy is the subject of a British patent. It consists of zinc, 80 to 85 per cent; aluminum, 14 to 19 per cent and copper, 1 to 2 per cent. The copper and aluminum first are melted together and water-quenched to form a hardener. The latter is remelted with the zinc to form the final alloy.

A commercial department has been established by the royal Netherlands legation at Washington to furnish information on trade matters to American merchants.

Iron to Withstand High Heat

By H. E. Diller

Question:—We manufacture a heating device which is sold upon its heating qualities rather than on its looks. We are using an iron with over 3 per cent silicon and low in sulphur. Can you recommend a composition which would give the iron a longer life under heat? Would steel in the mixture be of any benefit in this way?

Answer:—In making heating device castings to withstand high temperatures, the aim should be to get as hard an iron as you can without making it too brittle or too hard to machine. This aim should be kept in mind rather than to try to follow any prescribed formula which we could give you, as we are not sufficiently familiar with the size of your castings to specify definitely the best composition for your iron.

Broadly speaking, we would say that no particular effort should be made to keep the sulphur down, as it could run as high as 0.150 per cent without doing any particular damage. The amount of silicon in your iron would be largely dependent upon the thickness of your castings and the amount of sulphur in the iron. We should judge that about 2.25 per cent would be what you would require. Certainly more than 3 per cent silicon is too much. The manganese and phosphorus are rather unimportant and can be varied widely without harming the casting.

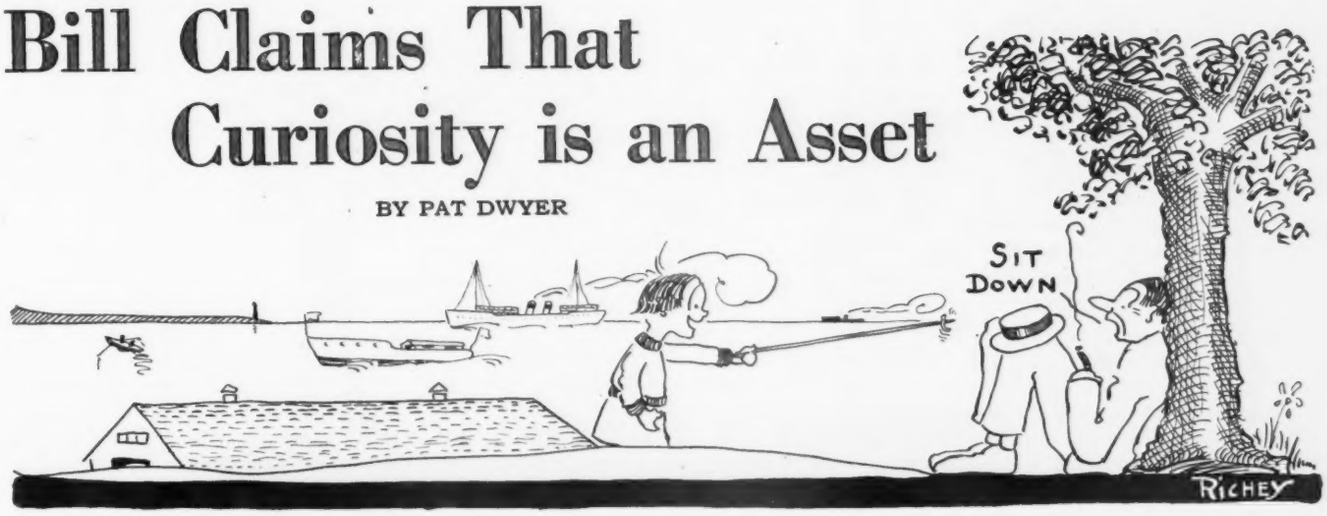
The use of steel in the mixture would not improve the casting for your purpose but would, on the other hand, make the iron set quicker and therefore more difficult to pour, besides increasing the shrinkage.

Properties of Mansfield Molding Sand

Mansfield molding sand has been used for many years in England. It is a red sand, and when ground in a pan mill, becomes tough, so much so that it is difficult to get a bad lift when the sand is used as a facing on the molds. In some parts of England the molders would regard it as a reflection on their skill to use Mansfield sand, but most of them use it to get good impressions of lettering. When well ground, this sand can be used for cores without the addition of binding material. Doncaster is a coarser sand that is not so tough as Mansfield sand. It is red in color and by mixing it with Mansfield sand, facings of varying degrees of toughness and openness can be obtained for molding use.

Bill Claims That Curiosity is an Asset

BY PAT DWYER



FROM the time the children learned to walk it has been my custom to take one or more of them out strolling on fine Sunday afternoons. As each of them reached Sunday school age, he or she, as the case might be, automatically dropped out of the program and the next oldest filled the gap and kept me company. Last Sunday, the hero for the time being, who is four years old and is frightened of nothing in the heavens above, the earth beneath, or the waters under the earth, took me confidently by the hand and proposed that we go down to the park and see the ships in the harbor. I agreed with him that it was a grand idea and we set out for this beauty spot which corresponds in a modest way to Battery park in New York. We drifted down by easy stages for there were some wonderful sights to be seen and commented upon as we went along. When we reached our destination, I picked out a shady spot under a tree to have a smoke while the young fellow ran around and enjoyed himself.

Our town is built on a peninsula something like New York in contour. It is not constructed on so large a scale you know—1 inch equals 1 foot to be exact—but the resemblance is so marked that visitors from abroad, with that wise air which visitors in general seem to affect, are led to remark on the similarity of the two places. Candor compels me to admit that if the visitor shows signs of not noticing this peculiarity some enterprising citizen makes it a point to draw his attention to it. There is a certain glamour or facination about all big cities. It is hard to describe but may be compared to a halo, an intangible something which the very name of the city calls up in one's mind, which makes people proud to claim it as their habitation or failing that to let people know that they have been there and seen all the wonders. I suppose if one were to analyze this feeling he would find that this glamour or facination owes its origin and existence to one of the oldest failings of the human mind—curiosity.

Eve—you know Eve of course—not as an abbreviation of Evelyn—but the original garden-of-Eden Eve, well, she had it and as a result of trying to satisfy her curiosity she and Adam were stung by the serpent. I hardly need say that this is not the word used in the original Hebrew, but may be accepted as a rather free translation. It lacks the depth, the euphony, the sonorousness of the native tongue, but I think I am quite safe in assuming that the reader will have no difficulty in reconciling the word with any account he may have read or may read in the future, as to what actually did happen to the original First Family.

One would think that with this sad example before them succeeding generations would have attempted to stamp out curiosity, but the history of the human race proves the contrary. It may be regarded as hereditary, and with all due respect to our sweethearts and wives (may they never meet) I think I am quite safe in saying that the female of the species carries off all the honors.

Throw your eye over history's shining page (I don't know why it is called shining, some of the pages are dark and gloomy enough) and you will find few examples of men causing trouble by their curiosity, but the ladies—Oh, boy! There was Lot's wife, who was not satisfied to beat it out of Sodom, she had to look back to see if the hack was coming with her trunk. You know what happened to her. Pharaoh's daughter went snooping around a bunch of bullrushes and the little fellow she found there came near putting Egypt on the blink before he finally was deported under the provisions of the alien labor law. Cleopatra was another curious lady. She tried to put a spoke in the wheel of the Roman empire, and nearly succeeded in wrecking the chariot, but it finished her career as a professional vampire.

I don't know where my meditations would have led me, like Tennyson's Dream of Fair Women, the subject is one that is very easy on the mind, but at this point in my reverie I saw my old friend Bill coming prowling along the boulevard. He had a derby hat cocked over one eye and a vilianous smelling cigar in the southwest corner of his mouth. "Hello," said he, "are you asleep or just giving your hands and face a rest?" "No," I said, "I am not asleep, I came down here with my youngest

ADAM AND EVE WERE STUNG BY THE SERPENT

son to take the air. He takes his running around, but I prefer takiug mine a la mode."

"A la mode is good," said Bill. "I don't know what it means but it sounds all right."

"Why," I said, "it means that I was sitting here thinking; I suppose you are willing to admit that there is a difference between sitting and thinking, and just sitting. I was thinking of some famous ladies."

"What kind of ladies," said Bill, brightening up perceptibly.

"Oh," I said, "Helen of Troy and Cleopatra and Joan of Arc and all those people."

"Just so," said Bill, "I see you are a dead one, wasting your time thinking over those hasbeens when there are all kinds of live young chickens parading up and down the boulevard in front of you."

"I am not a bird fancier," I said with dignity, "if you will kindly sit down on the lee side of me, or better still, throw that stogie away, I will tell you some things about those ladies that perhaps you never heard before."

"Sounds good," said Bill, "you may fire when ready, Gridley."

I told him of the train of thought that was running through my mind when he came along and put it up to him as an intelligent citizen if I was not right in laying the blame for all our troubles at the door of curiosity. I think I have mentioned elsewhere in these memoirs that Bill is a man of decided opinions. He will argue with any person, any place, any time, catch-as-catch-can. There is, however, one exception. I will not mention any names but between ourselves the first two initials of her name are Mrs. Bill. All of which simply goes to show that Bill is a man of discretion as well as valor. On this occasion he sat down and looked at me from under the edge of his derby.

HELLOW, SAID BILL, ARE YOU ASLEEP OR JUST GIVING YOUR HANDS AND FACE A REST

"I think the sun is melting your brains," said he, "judging by the drivel that is oozing out of you." He waited a minute to let that sink in and then continued: "Why, curiosity is what makes the world go around, if there was no curiosity the world would be as dead as those dames you were talking about a few minutes ago. I don't care whether you call it curiosity, ambition, dissatisfaction with existing conditions or just a plain nosey desire to know why the wheels go around; call it what you will, it is responsible for whatever improvements, enlightenment or advantages we enjoy in this twentieth century. Take our own business, the foundry, for instance."

"Oh! for heaven's sake give the foundry a rest for one day," I said. "I hear enough of it all the rest of the week."

"You can't hear too much of a good thing," said Bill, with a grin, "besides it is the only game I know anything about. You could lose me easily enough in the depths of ancient history; but when it comes to the foundry business, believe me, I am right there with both feet on the bottom and I don't need anybody to throw me a life line."

"Allright," I said, "I'll take your word for it, but if you get beyond your depth, I'll remember what you said."

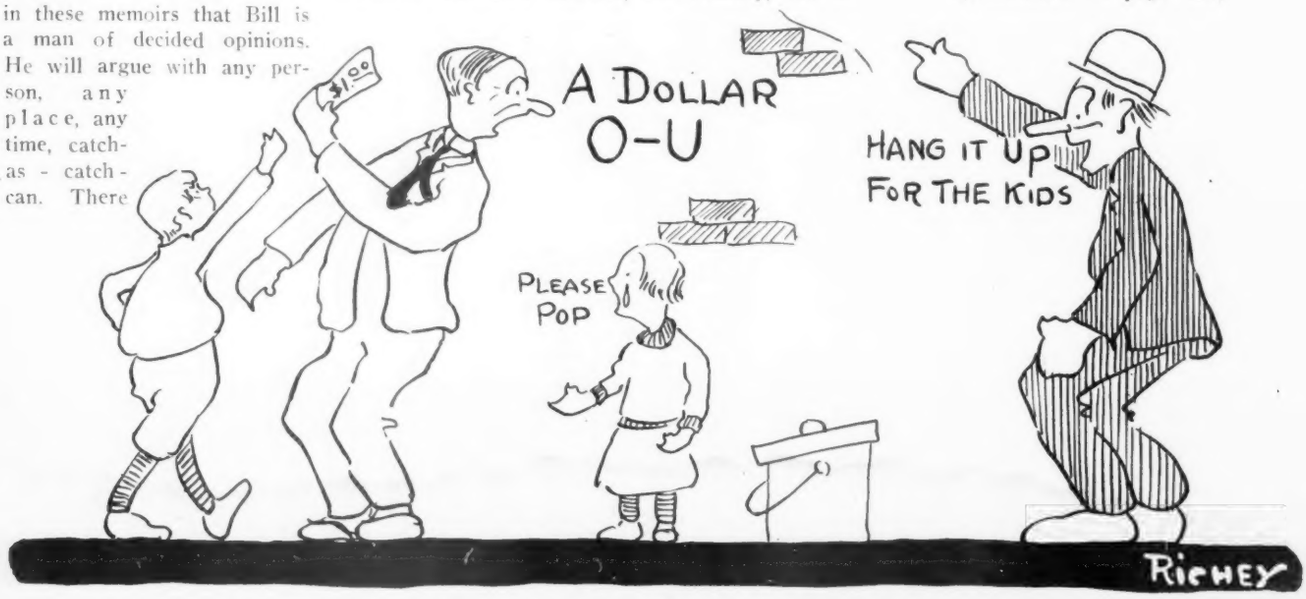
"I wouldn't put it past you to push me off into deep water if you got a chance," said he, "but I won't give you that chance. I could enumerate 40 reasons to prove my contention but I will confine myself to one."

"Go ahead then," I said to him, "but be brief, I'll have to go look for the young fellow in a minute and take him home. I was given special instructions before leaving not to come back without him."

"You are too easy," said he, "you want to assert your authority once in a while, now look at me."

"Oh, sure," I said, "I know all about you, if you exercised no more

(*Concluded on page* 564)



DON'T BE SUCH A TIGHTWAD, SAID BILL, HANG UP A DOLLAR

Facts Regarding Silica Refractories

Three Groups of Materials Used in Furnace Linings; Acid, Basic and Neutral—Silica is the Basis for Acid Linings — Theory Which Governs its Selection and Use

IN furnace construction, the use of refractory materials which have a long life and so assist in maintaining a continuous output is a factor of the greatest importance, and the careful selection of materials, the properties of which render them specially suitable for particular parts of the furnace, is a matter which cannot be overemphasized.

Refractory materials may be roughly classified into three groups, acid, neutral and basic, according to their chemical behavior. The acid group comprises siliceous bodies, such as fireclay and various forms of silica such as quartz, quartzites, ganister and sandstone. The most important neutral materials are chromite and graphite (plumbago), and the chief basic materials are dolomite, magnesite, lime, bauxite (and other forms of alumina) and zirconia. This paper deals with those acid refractories containing a high proportion of the acid-forming oxide silica.

The uses of highly siliceous materials such as sands and their related rocks in metallurgy comprise:

1.—The making of silica bricks.
2.—The lining and repairing of acid open-hearth furnaces.
3.—The lining of reheating furnaces.
4.—The making of molds.

Bigot had suggested that the suitability or otherwise of raw siliceous material for the manufacture of silica bricks can be roughly determined by taking pieces of them, weighing a few ounces and heating them gradually to a temperature just above 1700 degrees Cent., keeping them at that temperature for two or three hours. They are then allowed to cool very slowly, the furnace being lagged so that the cooling takes four to five hours. If the test pieces are melted, as will be the case with material containing excessive quantities of impurities, such as alkalies, lime or alumina, which will form fusible compounds, they will be unsuitable for use.

Phillipson considers, from the results of a series of carefully conducted experiments with quartz, quartzites and sandstone on a practical scale, that by suitable treatment satisfactory bricks may be made from a variety of quartz. This conclusion cannot yet be regarded as substantiated. So far as the author's experience goes, no brick will so well withstand many of the severe conditions met with in the manufacture of steel by present day practice as one made from the quartzite rock of ganister type.

Pebbles are another form of raw material now being used to some extent, and their use is quite likely to extend, as by suitable treatment quite satisfactory bricks can be produced.

Sand is occasionally used as a raw material. Its chief disadvantage is due to the absence of that natural cement which is found between the grains of quartzite rocks.

Texture Should be Uniform

The texture of a silica brick is a very important factor, and some reference should be made to it. Provided that the chemical composition and refractoriness are satisfactory, the behavior of the brick in use may largely depend on its texture and physical structure. On examination a silica brick will be seen to consist of fragments of crystalline silica embedded in a material which is frequently glassy in character, and is probably mainly composed of calcium silicate, calcium iron silicates and calcium alumina silicates. The size and shape of the fragments of silica have a definite influence on the behavior of the brick. It is desirable to have the brick composed of angular fragments of varying size from ¼-inch downwards together with a proportion of fine powder so that as in concrete there shall be as few voids as possible. Whether in particular brick the texture be coarse or fine it is very desirable that it should be uniform throughout. The coarser-grained open-textured brick will better resist sudden changes of temperature, but will, on the other hand, be susceptible to the penetrating action of fluxes such as fine dust, etc. Bricks of fine texture will resist the abrasive action of hot gases and the attack of fluxes better than bricks with a coarse texture. Silica bricks, whether of coarse or fine texture, are practically liable to splitting and spalling with abrupt changes of temperature.

There has been much controversy as to the exact stability relations of tridyonite and crystobalite. They are by no means simple, as they appear to be modified by the presence of certain fluxes. The general evidence as available does not confirm Fenner's determination of tridyonite-crystobalite inversion, but favors Le Chatelier's suggestion that tridyonite is stable above 1470 degrees.

It appears likely that in silica bricks the inversion in all cases takes place by solution of quartz in the viscous matrix with a crystallization from this solution as it becomes saturated by the other modifications.

The precise composition of the matrix largely influences the rate at which this solution takes place, and many observed differences in the time temperature-curve of the formation of tridyonite in silica bricks may be due not only to the size of the quartz grains but to the presence of impurities in the raw material, which in the matrix cause an increase in the rate of solution of the quartz.

In considering the refractoriness of silica bricks it must be remembered that silica has not a definite softening temperature, but that there is a range of temperature within which it begins to lose its shape and commences to flow, and it is extremely fortunate that this is so. This point is of great importance in measuring the refractoriness of a brick sample. If the temperature of the test furnace be rapidly raised the brick will apparently show a higher softening point, because equilibrium is not established throughout the test piece before it is raised to a higher temperature. That is to say the actual flowing of the silica lags behind the temperature, and the more rapid the increase in temperature the greater is the lag.

General speaking silica firebricks will carry load at high temperature better than aluminous firebricks as the softening range of silica is not affected by pressure to the same extent as fireclay. When silica bricks collapse under load at furnace temperature the failure is more of a mechanical nature and will be more or less abrupt instead of gradual.

Abstracted from a paper read at a meeting of the Birmingham Metallurgical society, Birmingham, England, by W. J. Rees, F. I. C.

Money Saved by Testing Laboratory

Watching the Composition of the Pig Iron and of the Finished Product Prevents Undue Irregularity of Metal in Castings and Enables the Foundry to Produce Higher Quality Malleable Castings

BY H. R. SIMONDS

INCREASED labor difficulties everywhere are continually bringing questions of plant efficiency into greater prominence. Methods of increasing and improving production are now more carefully studied than ever before. The relation between quantity and man-hours is not always the main consideration, but rather that of the value of the manufactured product compared with its labor cost. This involves constant striving toward improved quality and reduction of waste and lost motion, and also requires continual attention to detail in all the varied departments of any large plant. Departments for the sole purpose of studying methods of improving production have been developed in many plants and usually have proved invaluable soon after their installation. In iron foundries, however, such departments are rare and perhaps only justified under unusual circumstances. Makers of malleable castings, for instance, have the experience and research facilities of the laboratories of the American Malleable Castings association to call upon; nevertheless several makers have found that a private research department is an asset and a benefit to their foundry operations in many unforseen directions. Prominent among the concerns which have made special efforts in this direction is the Eastern Malleable Iron Co., which established a research department three years ago at its main plant at Naugatuck, Conn. From a simple laboratory for testing specimen iron bars this department has grown, under the direction of W. R. Bean, its supervisor, into a general clearing house for metallurgical problems which may develop in any of the five plants of the company. The department's activities are centered about a well equipped chemical laboratory but are by no means limited to this laboratory in their scope. If any new material is to be purchased, or if equipment or a new process is to be installed in any of the company's plants, a report is asked of the research department covering the proposed action. In fact, the value of having reports has become so pronounced that requests for the examination of entirely new phases of the business are continually being received at the laboratory. In the three years that the department has been in existence, 1087 reports have been compiled. The bulk of these of course cover subjects directly pertaining to metal but the wide variety of subjects may be seen from the following list taken at random from the files:

Determination of the best core oil to be used under certain existing conditions.

Report covering type and specifications of mechanical stokers for use in one of the plants.

A wheelbarrow test to determine type to be used in foundries.

Report an hand leathers.

Report on specifications to cover suitable sand blast or other cleaning device.

From the foregoing it is seen that while the laboratory is a necessary part of the department, the resourcefulness and ingenuity of the personnel of the department determine its usefulness in the organization.

The equipment of the department is unusually complete; on the first floor of the plant's main building there is an office containing cabinets, library and other facilities for study and for the filing of records. Adjoining this office is a mechanical testing room which is shown in part in Fig. 7.

Conveniently arranged at the left of the testing machine there is a solid oak table which proves of great convenience in sorting and arranging sample bars which are to be tested. Micrometer gages, scales, and other auxilliary apparatus are found in this room. It also contains the instruments for making microphotographs. These instruments are shown in Fig. 6. The camera, the microscope and the lantern are mounted on a single base. Fig. 5 shows the compact polishing set which is used in bringing the specimens to the smooth finish required in microphotography. Such a set is not uncommon in laboratory practice but it takes a good deal of study and experimenting to use it to the best advantage. The top disc is covered with felt, and powders and rouges put on the felt are used as abrasives. The chemical laboratory is on the second floor. As it is especially complete and well arranged, some detail concerning it may be of interest. A space about 20 x 50 feet is occupied by the weighing room, laboratory, office, and the main laboratory. The office and weighing room divides the first 15 feet of one end, and the laboratory occupies the remain-

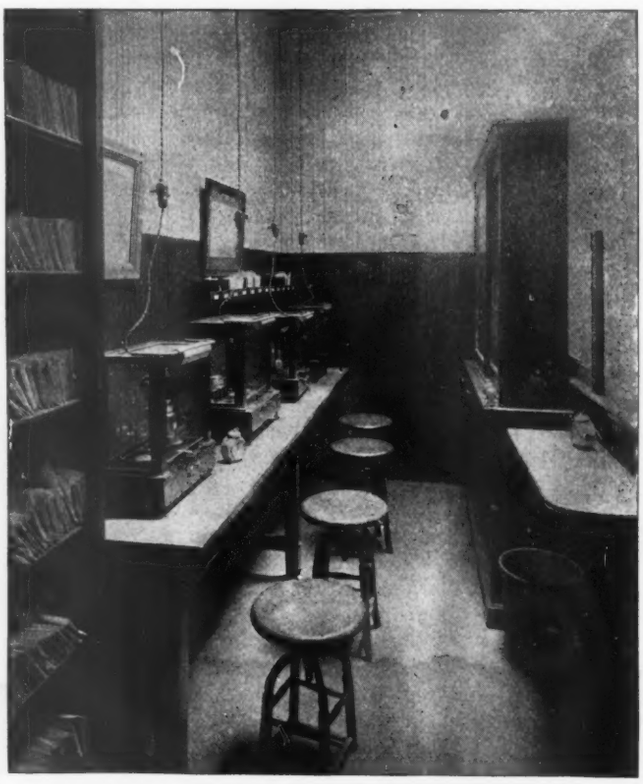


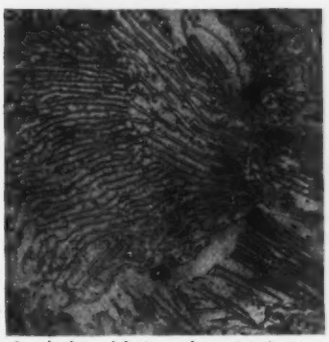
FIG. 1—AN IMPORTANT PART OF THE LABORATORY WORK IS THE WEIGHING OF SAMPLES AND SALTS—FOR THIS WORK FOUR ACCURATE BALANCES ARE USED

Form C-38

THE EASTERN MALLEABLE IRON CO.
RESEARCH DEPARTMENT
MICROSTRUCTURE REPORT

NO. 5

Sample No: 16-B
Sample of: Tensile Bar
Dimensions:
Kind of anneal: Regular



Date Feb. 5, 1919.
From: Bridgeport Wks.

Temp. Anneal:
Time Anneal:
Annealed in: Packing
Tensile Strength: 52757 lbs.
Elongation in 2 inches: 3.0 %
Transverse Test:
Load applied at center lbs.
Deflection at center inches
Magnification 250 diameters
Center of casting

Analysis: %
Silicon: .75
Manganese: .27
Sulphur: .062
Phosphorus: .272
Comb. Carbon:
Graph. Carbon:
Total Carbon: .92 annealed
Hard 9mm 2.43

Remarks:- This bar was annealed at too high a temperature. The structure shown is the coarse brilliant fracture typical of burned iron. #1. Pearlite, #2. Cementite. Note extreme size of crystals. These are 5 to 10 times larger than in well annealed malleable iron. Note extremely heavy decarburization as shown by carbon content of .92% due to increased activity of the packing at high temperatures. See physical test report No. 392.
Wedges from same heat showed normal fracture.

FIG. 2—MICROPHOTOGRAPHS ARE USED IN CONJUNCTION WITH PHYSICAL TESTS AND ARE OFTEN THE MEANS OF DETERMINING DEFECTIVE METHODS OF PRODUCTION

der. The laboratory proper, which is shown in Fig. 8, has two workbenches running throughout the greater portion of its length. Hoods and drying devices are provided at both ends of the room. Special emphasis is paid to neatness and cleanliness in all laboratory work. Convenient racks are provided for funnels, test tubes, beakers and other articles which are in constant use. Hot water, gas and electricity are convenient to all tables and benches. A space devoted to washing, which may be seen in the background at the right of Fig. 8 is provided with draining racks and other features to make the cleaning process as efficient as possible. The floor of the laboratory is of acid proof construction. It consists of a magnesite base ½-inch thick laid on expanded metal with a top coating about ⅛-inch thick of a plastic acidproof composition, which is trowelled on. This coating is a patented product made by an Illinois concern, and has proved entirely satisfactory both as to acidproof qualities and ease on the feet of the laboratory operators. The tables are heavy and solid with soapstone tops, such as are commonly used in chemical laboratories. The tables are placed lengthwise in the room and are arranged so as to make isles running to the hoods.

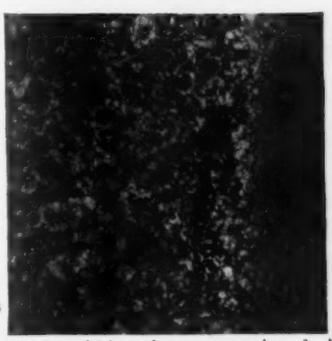
As most of the determinations in a metallurgical laboratory are quantitative, particular attention is paid to the apparatus in the weighing room. Four modern, accurate balances are mounted on a table along one side of the room with the usual stools in front for the operators. The samples of iron to be tested come in small envelopes which are placed in a rack above

Form C-38

THE EASTERN MALLEABLE IRON CO.
RESEARCH DEPARTMENT
MICROSTRUCTURE REPORT

NO. 8.

Sample No: 23
Sample of: H.H.Franklin Cstg.
Dimensions:
Kind of anneal: Regular



Date Feb. 7, 1919.
From: Troy Works

Temp. Anneal:
Time Anneal:
Annealed in:
Tensile Strength:
Elongation in 2 inches: %
Transverse Test:
Load applied at center lbs.
Deflection at center inches
Magnification 100 diameters
Outside of casting.

Analysis: #5552
Silicon: .70
Manganese: .28
Sulphur: .065
Phosphorus: .165
Comb. Carbon:
Graph. Carbon:
Total Carbon: 1.01

Remarks:- Showing (1) intermediate white rim, appearing between (2) outside decarburized rim of ferrite, and (3) center of ferrite and temper carbon. Probably the result of too nigh a temperature in the annealing process. See letter of Feb. 7, 1919 to Troy.

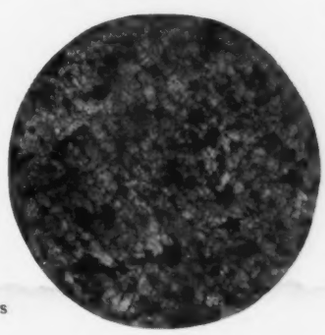
FIG. 3—TOO HIGH TEMPERATURE IN THE ANNEAL IS DETECTED BY A MICROPHOTOGRAPH OF THE FINISHED CASTING

Form C-38

THE EASTERN MALLEABLE IRON CO.
RESEARCH DEPARTMENT
MICROSTRUCTURE REPORT

NO. 4

Sample No: 6354
Sample of: Wedge
Dimensions:
Kind of anneal: Regular



Date Dec. 18th, 1917.
From: Troy Works.

Temp. Anneal:
Time Anneal: Regular
Annealed in:
Tensile Strength:
Elongation in 2 inches: %
Transverse Test:
Load applied at center lbs.
Deflection at center inches
Magnification 125 diameters

Analysis: %
Silicon: .81
Manganese: .25
Sulphur: .070
Phosphorus:
Comb. Carbon:
Graph. Carbon:
Total Carbon: 2.06

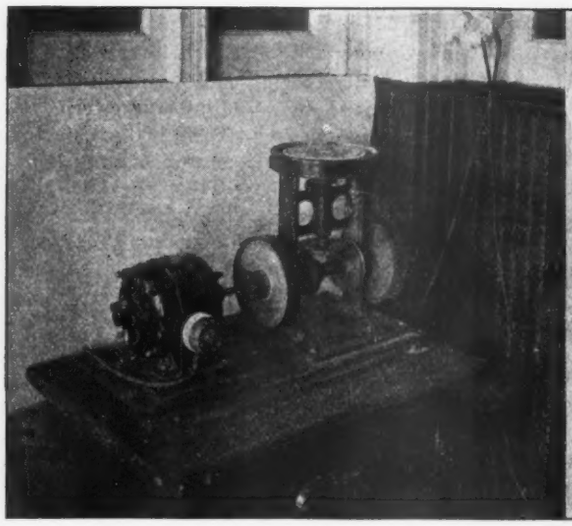
Remarks:- Specimen showed exceptional bending qualities.

FIG. 4—NOT ONLY ARE DEFECTIVE CASTINGS MICROPHOTOGRAPHED BUT UNUSUALLY GOOD ONES ARE ALSO STUDIED

the balances. Each envelope has the following list printed on it:

Sulphur
Silicon
Manganese
Phosphor
Checks
Special
Total carbon—A. K.
Total carbon—V. S.
All weighed.

When the sample is placed in the envelope, check marks are made after the items for which determinations are desired. Each envelope when once started, with its sample, in the rack of the weighing room follows a definite sequence until it is finally stored on the shelf of a filing cabinet. The first step is to pulverize the samples so they may be used in the different chemical tests. For the sec-



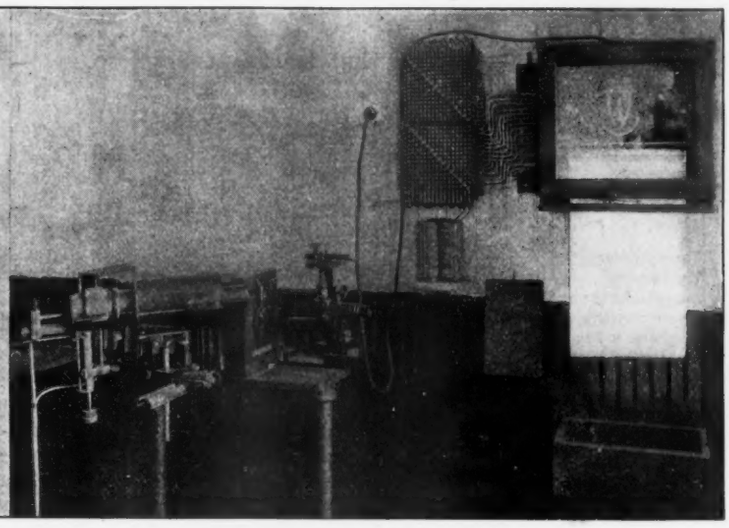


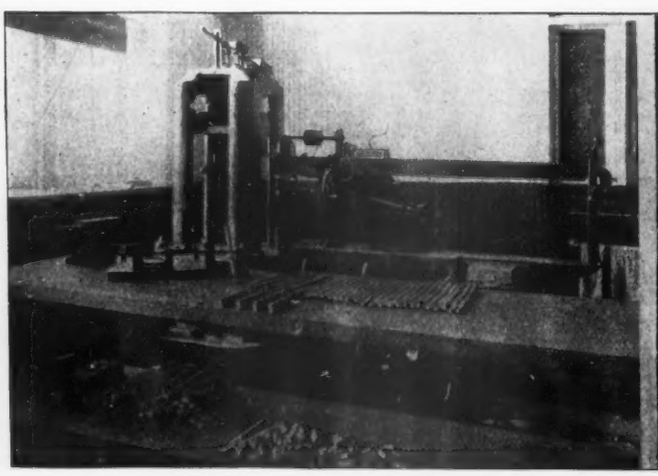
FIG. 5—SPECIMENS BEING FINISHED FOR MICROPHOTOGRAPHY ARE FIRST GROUND ON THE VERTICAL DISC WHEELS FIG. 6—THE MICROPHOTOGRAPHIC APPARATUS AT THE LEFT—AT THE RIGHT, THE RECORDING PYROMETER

ond step, in case sulphur has been checked on the envelope, a girl weighs out in a labeled beaker a definite amount of the pulverized sample, and turns it over to a laboratory assistant, who chemically determines the percentage of sulphur contained in the sample. The envelope, with the remainder of the sample, then is placed along the rack in a pocket which is labeled to correspond with the next checked item on the list. The pockets or compartments of the rack are labeled from right to left, with the same items and in the same sequence as in the list appearing on the front of each envelope, so that if, for instance, the sample has all items checked, its envelope will pass consecutively from the right hand compartment to the one labeled, *all weighed*, at the left end. If some items are not checked, the envelope is skipped over the compartments corresponding to the unchecked names. As the samples accumulate in the last pocket they are taken by an assistant from the office and the results are copied on special forms for delivery to the proper person or persons interested.

Each sample coming in has its works or plant number, and is given a new number, known as a laboratory number. Both of these are recorded in a book kept for the purpose. Each test and every procedure in connection with the samples from then on is kept track of by the laboratory number. When a sample is to be placed in a tube, beaker or any other receptacle for use in the laboratory, the receptacle is marked with the laboratory number of the sample, and it is is in this way possible to handle a large number of samples without confusion as to the different reports. The carbon determination is always made in two entirely independent tests by different people. Two girls as a rule work on nothing else but the weighing for carbon determinations. The initials of one girl are A. K.; and the other girl's initials are V. S., which explains the letters appearing on each envelope after the two items—Total Carbon. The independent results of these two girls are averaged to give the final carbon value. In the rare cases where there seems to be too great a variation in these two values, check determinations are made.

One item which illustrates the precision used in work of this character is the electric light mounted in front of each scale. This light consists of a symmetrical tube, especially made for the purpose to give evenly distributed light. The light fixture itself is symmetrical about the central plane of the scale. This is so that the heat from the electric light will affect both arms of the scale equally, and will thus compensate for any tendency toward error.

The work in the laboratory usually results in the separation of a compound containing the element for which the test is being made. Thus for the silicon test for instance, the sample after being treated with acid



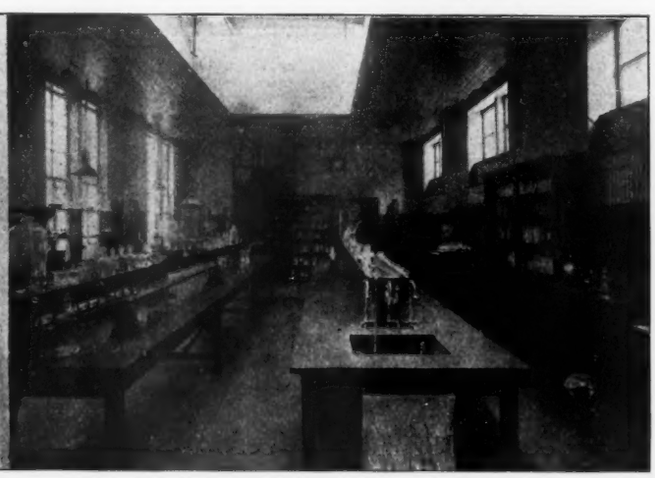


FIG. 7—PART OF MECHANICAL-TESTING ROOM SHOWING THE CONVENIENTLY ARRANGED TABLES AND THE SPECIMEN BARS AND WEDGES READY FOR TESTING FIG. 8—ROOM IN WHICH GENERAL CHEMICAL WORK IS DONE—CLEANLINESS IS ESSENTIAL

is brought down to dryness, and another acid is added; it is then filtered after which the residue is burned off, silicon dioxide remaining in the crucible. This SiO_2 is then weighed and from a table the per cent of silicon is read directly and entered on the envelope. Two of the tables used for this purpose are shown on frames on the wall above the scales, Fig. 1. Of course in the determination of other elements the process varies.

The laboratory proper is run independently of the weighing room as far as the work is concerned. Miss Beatrice M. Smith, a graduate of Holyoke college, and formerly instructor in chemistry there, is in direct charge of the entire laboratory work. She has four girls and three

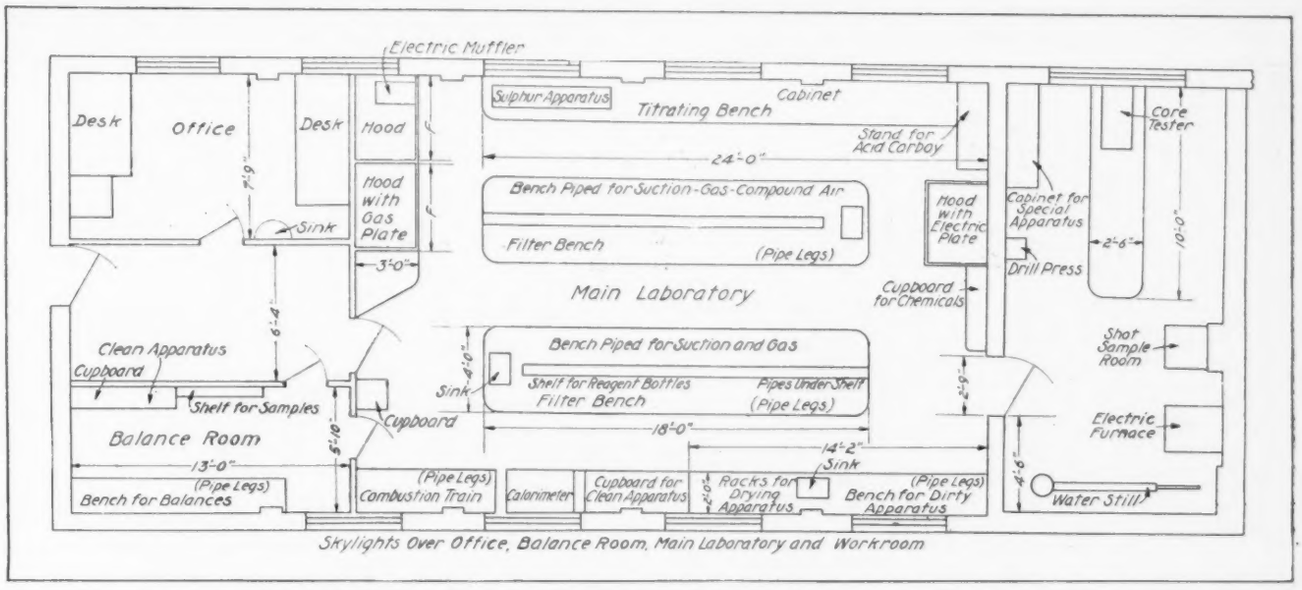


FIG. 9—THE MAIN LABORATORY ROOM IS LARGE AND CONVENIENTLY ARRANGED PARTICULAR EMPHASIS IS PLACED ON CLEANLINESS IN ALL WORK

men as her assistants and some idea of the amount of work handled each day may be gathered from the fact that analysis is made of each car of pig iron used in all of the five plants and also of each heat which is poured anywhere in the organization. Every effort is made to get the results of these tests in the hands of melters as soon as possible, in order that the necessary changes in mixture may be made to keep results close to predetermined formulas.

In addition to the chemical analyses, physical tests are made of bars cast from each heat. Wedges are also cast for testing on the Walker impact machine. It is impossible to give here more than a hint as to the complete work of the research department. In addition to the chemical and physical tests, exhaustive microstructure studies are made. If a test bar fails under too low tension, it is immediately examined to determine if possible the reason for the failure. Microphotographs are invaluable in this work and while the importance of their use is sometimes exaggerated, the rapid advancement in the quality of bars of the Eastern Malleable Iron Co. has been possible only through careful study of the microstructure of the iron and the reports on them which are kept in the laboratory files.

Figs. 2, 3 and 4 show four typical micrographs. The first shows a bar annealed at too high a temperature with the coarse brilliant structure typical of burnt iron. The second shows a decarbonized effect; the rim is of ferrite and the center contains ferrite and temper carbon. This is probably the result of too high temperature in the annealing process. The third shows a good sample of high carbon iron which developed exceptional bending qualities.

When the research department was first started, the average tensile strength of the malleable iron produced by the company did not average 40,000 pounds per square inch, and the elongation in 2 inches was under 10 per cent. A physical test report taken at random from the recent files shows an average tensile strength above 54,000 pounds per square inch and an average elongation in excess of 14 per cent in 2 inches. This progress cannot of course all be attributed to the fact that a research department was in existence, but it is safe to say that making many tests and closely studying the results of these tests, then applying the knowledge gained has been an important factor in developing quality as well as in increasing efficiency in the plant.

Method of Gating Test Bars Affects Results

By A. W. Sorgenz

The proper annealing of steel castings to meet definite physical specifications has nearly always been a difficult proposition for the average foundryman. Not usually claiming to be a heat-treating expert, he is prone to place too much emphasis on those details with which he is unfamiliar. He is told by those who have had more experience that an annealing temperature of 1550 degrees Fahr. is the vital requirement for his class of work. Then if the temperature runs up to 1600 degrees, and the test falls down, he feels sure that the high temperature was responsible. Now it is true that a piece of steel will exhibit better characteristics if annealed just above its critical range, than if heated to a temperature some hundred degrees higher. But in low-carbon steel castings, under 0.30 per cent carbon, little difference in quality results from a variation in the annealing temperature of 150 degrees or so above the critical range. A piece annealed at 1650 degrees will meet the ordinary specifications almost as readily as one annealed at 1500 to 1550 degrees, showing that the temperature need not be kept within close limits.

On the other hand, too much emphasis cannot be placed on the proper method of casting the test bars. This is a point which is often overlooked as a result of giving undue attention to minor details. The effect of improper practice in casting test coupons is shown in the micrograph, Fig. 2. Particles of slag, indicated by the black spots in the illustration,

have decarbonized the adjacent metal, the combination of slag and ferrite forming a line of weakness through the test bar.

The trouble in this case was due to the method of casting. The test coupon was attached to the casting by a neck about ½-inch wide, as shown in Fig. 1. The metal in this neck froze quickly, thus preventing the proper feeding of the test coupon and the escape of gas and slag. The neck was made in order to allow easy removal of the test coupon from the casting. The trouble was remedied by running the test coupon straight up to the casting, allowing perfect feeding and ready escape of impurities, as shown in Fig. 4.

Before annealing, the test coupon was flame-cut close to the casting, and left attached to the casting by a section ½-inch long. Then its removal was effected with comparatively

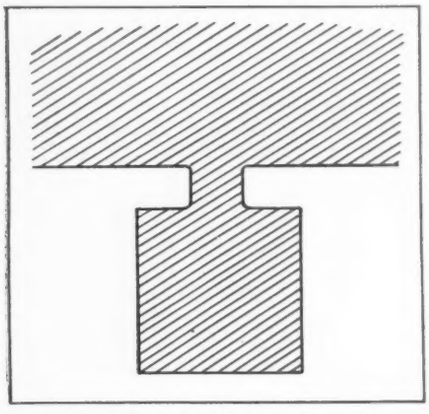


FIG. 1—IMPROPER METHOD OF CASTING TEST COUPON

little trouble after the anneal. It is always advisable to place the test coupon on the under side of a casting when possible. If the bar is to be poured separately, the method shown in Fig. 3 will prove satisfactory. The upper part acts as a feeder for the coupon proper. A test coupon should never be cast on end.

Furnaces Equipped with Pyrometers

Good results can be obtained only with properly designed furnaces. While theoretically the underfired furnace is best, most foundrymen, with good reason, prefer the car-bottom type with which underfiring is somewhat difficult. The oven-fired furnace is generally recognized as being well adapted to foundry use. Whether the checkered-arch type with combustion chamber above, or of the open-flame type is used, the main consideration is that the flame shall not strike the charge so as to produce local overheating.

Pyrometers are necessary if definite, dependable annealing results are to be obtained. It is advisable to have one thermocouple between every two burners, so that each burner may be under control. Another arrangement is to place one couple at the hottest point of the charge and another at the coolest point, say about six or eight inches from the furnace floor. By regulating the heat so that the hotter couple is never above the desired temperature, and maintaining this heat until the other couple likewise attains the desired temperature, a regular anneal is assured.

FIG. 2—MICROGRAPH OF STEEL SHOWING SLAG INCLOSURES

Double Annealing Recommended

For the most particular work, two annealings are always desirable. The first may be at a temperature of 1700 to 1800 degrees. This can never do a casting any harm and nearly always has a beneficial effect in that it breaks up the structure as cast. The second heat should be just above the critical range of the steel being treated, say 1500 degrees for steel with 0.25 to 0.40 per cent carbon, and 1450 degrees for steel with carbon above 0.40 per cent. If only one annealing is desired, the temperature, and more especially the time-factor, will vary with the quality of the steel as well as with the carbon content. The writer has obtained excellent results from a piece of 0.25 per cent carbon basic electric-steel after annealing only 15 minutes at a temperature of 1500 degrees, whereas he has had poor results with inferior pieces of steel even after heating for three to five hours. Good steel will stand considerable abuse and variation in annealing temperature without being injuriously affected, while even the most careful treatment fails to produce good results in steel of poor quality. Generally speaking, most failures in annealing low-carbon castings are due not so much to the average temperature, as to nonuniformity in heating and to underestimation of the time factor. It is well to conduct careful experiments with all annealing furnaces to determine the actual time required for all parts of the furnace to reach a definite temperature with a charge of given weight rather than to work on a mere assumption, as temperature variations in a large furnace are quite deceptive even to a trained eye.

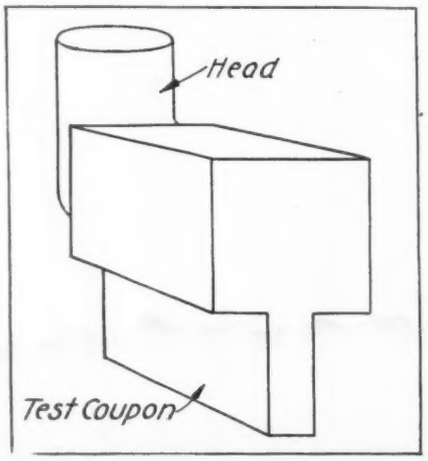


FIG. 3—RECOMMENDED METHOD OF CASTING SEPARATE TEST COUPON

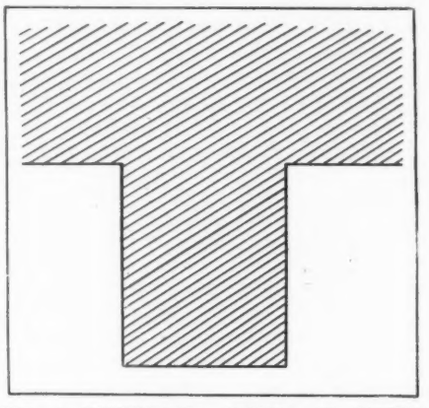


FIG. 4—RECOMMENDED METHOD OF CASTING ATTACHED TEST COUPON

The New York Testing Laboratories recently organized by L. R. Seidell, G. B. Jack Jr. and H. H. Geist, metallurgists, formerly connected with the Wright-Martin Aircraft Corp., have established offices at 74-80 Washington street, New York, in addition to those maintained at the laboratory in Newark, N. J.

A new course in ornamental modeling has been inaugurated at the school of arts of the Carnegie Institute of Technology, Pittsburgh. Students will be instructed to mold in clay, to transfer the design to plaster of paris, and to cast metal in the molds thus prepared. Both day and night courses are provided.

The Niagara Brass Mfg. Co., brass and aluminum founders and machinists, recently removed from Buffalo to Lockport, N. Y.

Long Castings From Short Patterns

A Few Pertinent Hints On Molding Light and Heavy Bushings — Either Dry Or Green Sand Cores May Be Employed — Bushings May Be Molded Lying Down Or Standing Up

BY R. R. CLARKE

THE suggestions contained in this article apply chiefly to molding pins and bushings in a standing position and proceed from a desire to reduce the pattern cost. Besides the methods to be advocated are favored by a slight improvement in molding and the decided advantage of keeping down the number of patterns made or carried in stock. Provided correct methods prevail, it is easier to make a pin casting 20 inches long from a 12-inch pattern than from a 20-inch pattern. Most all brass foundries make pins and bushings in different lengths ranging from 10 to 18 and 20 inches. It is plain that by this method, 10 inch patterns will cover all cases by virtue not only of different lengths drawn to but also of different sized core prints attachable. A still further commendable feature in the case of small cored bushings is the guarantee against the core bending or shifting out of center by the action of the metal. Standing upright in the mold when casting, a dry core of most any length will retain a central position without resort to anchors. A disadvantage that must be reckoned with is burning the core solid in the deeper vicinities of the mold where the metal pressure is greatest. This is especially critical where the mold is bottom gated, subjecting that part of the core to all the live and flowing metal required to fill the mold. In such cases special attention must be given the core mixture and the core wash. These same metal conditions increase the liability of the metal to force into the core vent and cause a blown casting and suggest the necessity of ample protection against such a probability.

Details Given Consideration

In detail this method of molding admits many important considerations sometimes overlooked. It is in the details of procedure that most castings are lost and this suggests the probable value of considering the details of the case in question. In the general run of foundry experience the average man seldom reckons with the hard facts of detail until some attending misfortune drives him to it. It is this more than anything else perhaps that explains why the first few castings from an out-of-the-ordinary pattern are frequently lost, this loss representing apparently that experience necessary to an appreciation of the facts in the case. Molding is an art in which general truths predominate. With respect to a peculiarly sized and shaped pattern, it is doubtful if any real particular truths are connected with it so that the loss of a casting merely because of its oddity to experience is not altogether justified. Such loss represents a failure to study and apply truth rather than a break in the continuity of truth.

Patterns With Minimum Draft

The subject divides into two phases, molding the smaller sized pins and the smaller sized bushings with a dry core and molding the larger bushings with either green or dry core.

The first consideration is the pattern, which should be true in every detail, kept in best condition and contain a minimum of draft. Abnormal pattern draft causes variation in casting size besides being responsible for breaks in the mold which are always unsightly and sometimes serious. These breaks come from the incrushing of the sand following the tamping after each drawing up of the pattern. Since very slight draft is needed the folly of courting the evils of prominent draft becomes the more significant.

Rough patterns are a menace to best results. To score a deep, close-walled mold with little chance of dressing the scars away invariably results in an unsightly casting. Ends of patterns suffer most and deserve all the protection that can be given. Disks made of brass or aluminum, well machined and neatly attached answer the purpose well. Pattern core prints should be correct in size, fit neatly and always observe strict central position. The cope print should taper perceptibly and the core made to correspond. The practice of using no cope print at all, though frequently followed, is not a good one.

Next to the pattern the condition of sand is in order. Every deep mold must be tamped hard in its lower parts or the casting will swell. Only well and judiciously tempered sand will stand hard tamping and not give trouble. It should be worked rather dry and be of good body. Best results follow sieving all the sand used. In so doing no worse practice could be followed than to sieve into the flask. Skirting the bottom edges of a pile of sieved sand are always small, coarse lumps of sand. They represent a roughness and inconsistency of tempering that can never be safely trusted to border the pattern around which they collect in sieving over it.

Next in order comes the flask. This usually has to be built up from parts of several flasks. The better plan is to strive to realize level partings by resorting to frames or upsets of proper depths. Suppose you want to make a 17-inch pin or bushing from a 10-inch pattern in a flask where cope and drag are 4 inches deep. All you need is four parts of the flask and a 1-inch frame. Should the flask parts be either 3 or 5 inches deep a 2-inch frame will control the situation. The chief advantages of a level parting in both cope and drag associate with dressing around the core in the drag, with lining the core up and with the more solid and artistic condition of the sand bordering the pattern after it is drawn. A prime essential in the flask and all frames used is strength and rigidity.

How to Get a Swollen Casting

In deep mold work if you want a sadly swollen and out of shape casting use a weak flask or frame and you'll be satisfied. Flasks or parts of flasks that are bad in the joints constitute an equally threatening menace. Added to the possibility of a run-out is the liability to crush the mold in weighing or clamping and the chance of throwing the mold out of line from its rammed-up position. More than one bushing has had its core come out of center by this condition in the flask. In molding bushings, the mold has to be closed over the core in assembling. This suggests the facility offered by making several partings in the cheek. If that part be 24 inches deep it is well to make at least two partings beside cope and drag parting. When sec-

tions of such parted molds are of different depths the wisest policy is to so part as to make the lowermost section the least of all in depth and thus further facilitate the closing of the mold over the core.

The object of mold parting is to escape heavy weight in disassembling and later in assembling. This later assembling is sometimes attended by a declination of the mold or some section from its rammed-up position, which gives a crooked pin or bushing. Among its causes, that of flask joints not well cleaned and not bearing close face to face all around, is a prominent one. Other causes are loose flask guides, shifting of intermediate flask parts or frames, and improper methods in drawing the clamps.

Details of molding might well form the next consideration. The main thing is to start right. The drag is first rammed up and the sand surface on the mold side made perfectly level and solid all around. The ramming can be done either on the bottom board or on a follow board, and in the latter case the flask is rolled over. Between the two we are partial to the follow-board method in that it is the natural one and gives a more correct condition of tamped sand. We observe this method in the smaller sized flasks, though in the larger we take advantage of the greater facility offered by the other plan.

How to Tamp the Mold

In either case it is important that core prints, which always occur in the part of the mold, be made to observe a strictly level position and a perfectly rigid bearing in the sand. If they are the least bit inclined or poorly supported, the chances of ramming the pattern out of straight line are increased. This straight line, perpendicular position of the pattern should be carefully striven for.

During first ramming and until fully established the pattern should be firmly held to its seat on the core print. Naturally the bottom of any deep mold must be rammed hard. Proper ramming consists in keeping away from the pattern about an inch and tamping hard and at length. In tamping any mold one blow of the rammer can never properly do the work of two in producing rigidity and uniformity no matter how close the latter may approximate twice the force of the former. Nearing the top of the mold the tamping should lighten considerably.

To keep the pattern in perfectly straight line in drawing it up is important. For this reason the pattern should not be given first drawing until at least three-fourths of its length is securely tamped; nor should it at any time be raised over one-fourth of its length between successive tampings. If a pattern 12 inches long be drawn 3 inches when tamped up to 9 inches, only 6 inches will remain in the sand which is none too much to keep it in straight-line position during the following tamping. Of further importance is the core to anchor it in this position after each drawing. This can be done by uniformly tucking the sand against the pattern sides before starting to tamp.

Two or More in a Flask

When two or more bushing patterns are made in the same flask the difficulty of closing the mold becomes greater. This difficulty can be lessened by lining the core up straight before closing. This is a wise plan anyhow since too much moving the top end of the core after closing is liable to cause a break in the drag sand into which the core is bedded. A plan sometimes followed is to set the pattern on the core print before drawing the print, hold it firmly in position while placing three or four long straight wires against the pattern sides and equidistant from each other. These wires are pushed firmly into the sand of the drag after which the core print is drawn and the core set and lined up to the wires at the top end. The wires are then drawn and the mold closed showing an almost central position of the core at the top end.

The longer any core is the more liable it is to blow, all things else being equal. A very common cause of core blowing is the choking of the vent, and it is primarily essential that this does not materialize in the core in question. Vents should be taken off both top and bottom and extreme care exercised that the metal does not get into them, for whether core blowing follow or not, the admission of metal to a vent in any core favors sand-burning and increased cost in cleaning. Cores fitting neatly in their prints favor the vent, though this is not sufficient on the cope side where no dressing of the sand around the core is possible. In this locality some pasty or plastic material must be resorted to, such as flour and water, compound and water, putty, etc. Perhaps the best practice is to extend by pipe punching the core-print mold entirely through the cope, setting a vent wire in the vent of the core after assembling the mold and lightly ramming the sand over the top of the core. In following this practice care should be taken not to disturb the sand of the mold proper while the molder is doing the tamping.

As to gating, our best results have followed the bottom method. The gate is cut in the drag at an acute angle to the core so that the metal will rise from under the mold and escape striking the core directly in any fashion. Risers are taken off but do not attach directly to the casting. Some foundries observe gating at the top, others resort to half way or two-thirds down the mold though we could never divine the wisdom of anything but the bottom gate. Metal temperature in pouring the solid pin brass should be hot. Cold metal and trouble are synonymous in this class of work. In the case of bushings it should be as hot as the core will stand without severely burning in.

With reference to the riser attached to the casting, we were never able to realize a casting more satisfactory with it than without it when the metal is right, so we desist from wasting metal on it. In clean hot metal and ample gate pressure we have more faith by far than in many risers when working the more common alloys. When for any reason the casting attaching riser is honored, we cease pouring in the pouring gate and complete the pouring in the riser as soon as the metal is seen to appear in it. This is the only method in which the riser can lay claim to any logic so far as we can see.

Large Bushings With Green-Sand Core

Molding the larger bushings with a dry-sand core is practically the same thing as in the smaller ones only on a larger scale. Any increase in difficulty or diversion in practice can be covered in discussing the larger bushing with a green core to which we will next accord attention. This phase of the problem is undoubtedly more critical. There is a vast difference between molten metal in a rebellious and failing mold of large dimensions and one of small content; between 500 or 600 pounds of such metal and 40 or 50 pounds. There is none the less difference between the loss represented in the defective castings respectively. It is just as easy to lose a small as a large one but the fuss is less, the danger to the safety of workmen and equipment much reduced and the cost not nearly so high. All we have written on the former type of work applies the more potently to the latter. The strength and absolute security of the flask, the condition of the joints, of the pattern, the sand, the metal and all appear correspondingly the more important. The same chances simply cannot be taken on

large bodies of mold metal as on smaller ones; neither will the green core respond to the same treatment as the dry. The two represent an altogether different case in which the green core demands the more critical attention.

The question might be asked "When can a green core displace a dry core in any type of bushing?" That depends mostly on certain ratios, ratios for instance between core diameter and core length, between core bulk and metal bulk, and metal bulk surrounding it, etc. In many cases, large bushings weighing up to a ton are made with green cores, little more than skin-dried and the mold poured in horizontal position, but it cannot be judiciously attempted in all cases. To closely define these ratios and limits in any method of molding bushings would admit an evaluation which practice under varying circumstances and conditions might well repudiate and we make no attempt. The affair is largely a matter of judgment influenced by the facts in the individual case. We would not hesitate to mold a green core bushing 30 inches long, 18-inch core surrounded by metal 1 inch thick but we would parley with judgment before attempting to mold the same sized bushing with 4-inch instead of 1-inch metal wall. We could feel safe to so mold a 12-inch bushing with a 5-inch core, but could not escape serious doubt on the policy of molding the same bushing 24 inches long.

Advantages of Green-Sand Core

What advantage has the green over the dry core in any method of molding? In the larger classes of work the green core must be understood to be a molding sand core sometimes lightly faced and always surface blackened and treated to a molasses water solution and at least well skin dried. In such condition it possesses prominent advantages. It is ultimately a cheaper core, it lessens the cost of cleaning and gives by far a smoother, cleaner casting skin or surface. Besides it is always by far the less rigid and more cushion-like, conforming most obligingly to and relieving the hard strain of the metal contraction in the bushing wall. It is furthermore the less liable to cause metal to blow or simmer, and all in all a great help when properly manipulated toward a clean solid bushing. However, it is not without its disadvantages. It is more liable to scab, to wash, to collapse, to strain, etc., especially when the mold is poured in a lying-down position.

Still another question might be considered. It is that of advantages between casting the larger bushings in standing-up rather than lying-down position. All things considered the advantage is not so great either way. We can make clean solid castings both ways. The lying-down position is undoubtedly the cheaper and more commodious, but we believe it at the same time to be the less dependable in critical cases where an absolutely clean and solid casting is in demand. The cope side of a bushing poured in the lying-down position is always something to occasion concern and has very frequently been found to include evidence of the most damaging nature. The conditions are such as to easily admit the situation. The metal enters the mold violently and under lateral freedom. It sweeps the entire surface of the mold, gathers up all dirt and dross and is extremely liable to deposit them in some very critical casting vicinity. Furthermore it rises up on either side of the core to reunite at the top. Should it chill unduly the union line cannot always be trusted.

Action of the Core

Of still further significance is the action of the core. If at all inclined to give trouble it finds the situation inviting in the metal over it, which is the natural direction of its gases. In the standing-up position these conditions are not nearly so prominent. Dirt and dross have a determined and very limited area in which to locate, a vicinity at the same time of low particularity or that can be made so. The core does not find the conditions so favorable and the flowing metal cannot escape a better control. An argument sometimes advanced against the standing-up method and especially when bottom gated, is the chilling of the metal in descending the gate and rising in the mold. This contention is founded on a fallacy. The difference in time required to fill a mold properly gated at the bottom and poured vertically and the same mold poured on the level is absolutely negligible. Either mold will take the metal as fast as it can be poured into the ordinary sprue and the time element does not therefore vary. That the route is longer is true but the condition of the metal ascending the riser after having risen through the mold indicates no difference on that account as compared with the other method. A prominent advantage of bottom-pouring arises from the influence of the gate to keep the mold metal in gentle upward commotion establishing a uniformity of temperature and carrying dross to a surface position. In the deepest molds this condition prevails much the same as deep tanks filled with water from the bottom side.

Now we are not attempting to decry the lying-down position of bushings. It is the cheaper, easier plan but as already stated not so dependable in critical cases. An example might bear mention. Over a year ago we were asked to try making a pump-body casting which would stand 8000 pounds per square inch working pressure. Castings from this same pattern had been obtained from reliable manufacturers and failed when applied. We rigged up a flask to admit casting on end, placing the most critical part at the bottom and there gating. The alloy was a good hydraulic combination and given careful furnace practice. The casting was delivered to the consumer who tried it and found it perfectly satisfactory. We have good reason to attach strong significance to the molding and pouring practice in attaining these results, since several castings made in the same foundry had failed under test.

The large bushing made with green core and from short pattern invites many chances of failure. In conversation with an experienced foundryman once he remarked that he had never been able to obtain a thoroughly satisfactory casting by this method, that something always went wrong in one way or other. We inquired what a few of those somethings were. A varying thickness, a scabbed and rough inside surface, an out of center hole, an upper section spongy and drossy, a lower section too thin in the bushing wall and a crooked casting were the chief complaints. Looking straight at them we see in these misfortunes only those results most likely to materialize and most to be guarded against in casting nonferrous metals.

Making a Large Ring

Not long ago we were obliged to personally make a bushing 20 inches inside, 22 inches outside and 36 inches long from a ring pattern 8 inches deep. The casting was intended for heavy hydraulic pressure service and consequently particular. It was made on a Sunday and delivered the next day perfectly satisfactory in every respect. A brief account of the details of practice observed will suffice to make clear successful tactics in all similar cases. A light facing was made from equal parts of new and old, of a good and fairly open sand, this facing base being mixed 10 to 1 with a good core binding compound and well tempered with weak molasses water. This facing was made to face the pattern all around to a depth of approximately 1 inch and the mold backed with heap sand.

Steel flasks in which parts were exactly 4 inches deep were used and so arranged as to allow a parting every two parts or 8 inches. The joints were scrupulously cleaned and inside surfaces painted with a mixture of blue clay and water. After ramming up a blank drag the pattern and gate were set and parting dusted around the outside. Two flask sections were then placed on the drag, firmly clamped down and rammed up both inside and outside of the pattern. In ramming the inside or core of the pattern six "soldiers" or anchors, 2 x 2 x 11¾ inches long, were placed equidistant in a circle in the core and 2 inches from the pattern. These soldiers were embedded in the drag sand and rested on the bottom board.

In the exact center of the core a vent hole 2 inches in diameter was pipe punched, this hole reaching into the drag sand. The mold was then generously vented with a fine vent wire. A perfectly level parting was then made and the pattern drawn 2 inches. Two more flask sections were then set in place and rammed up on the outside of the pattern only, the ramming being done by four successive 2-inch drawings up of the pattern. An outside parting was then made and the pattern taken out of the mold, set on a perfectly level follow board and the core there rammed up in exactly the same manner as before with respect to "soldiers" and vents. The pattern was then taken and set back in the mold the core being anchored in the pattern by a short bar suspended on a wire which was supported by a top bar placed on the pattern's upper edges. That completed half the length required in the casting and the gate was then broken to guard against an excessive height for dropping the metal in pouring.

The Mold Was Skin Dried

The mold was then completed by ramming up two more quarter sections in precisely the same way, each core section having been made with the pattern out of the mold and afterwards set back into the mold, the pattern acting as a carrier, and the outside walls of the mold serving as a true guide.

The cope of the mold was then made on a level follow board, dusted with white parting compound and set on the mold to locate gate and vent hole positions. Following this the mold was disassembled and the four quarter sections set to one side on the foundry floor where they were thoroughly rubbed with dry plumbago and then brushed with a molasses water solution. In the center of each section a wood fire was built and allowed to burn for about an hour. The core was then calipered and found exactly uniform, no bottom swelling or bulging being at all in evidence. It was likewise treated to plumbago and molasses water and skin dried with a Hauck blow torch. The mold, of course, was bottom gated and a riser was taken off the top to relieve the strain of pouring. This riser was of the set-back type and not attached directly to the casting. To the 4 inches in height above the casting, as given by the cope, 4 inches more were added by using cups or heads, making 8 inches in all. The mold was firmly clamped on all four sides, the core sand well weighted and the metal poured hot. As already stated the casting had to meet the exactions of hydraulic pressure service and was found fully capable in every respect. We believe that if similar common sense precautions be taken in all cases no trouble will be experienced in making remarkably clean, solid and true castings by this method.

Getting Down to the Motive

A passing glance at the motive back of these several precautions might be worth the taking. We gated at the bottom chiefly to exempt the mold sand of the ravages of the falling metal and to assure it a clean, gate-skimmed metal. We cleaned the flask joints and clamped tight as we went along to be sure that the mold when finally clamped and poured would observe its strict rammed-up position. We used soldiers in the core and to the bottom board so that the core by its own weight would not in any wise collapse. We calipered the core to make sure of its correct dimensions at all points.

Had it been at any point too thick we would have shaved it down. We used a coarse rather than a fine sand because that bulk of metal in that mold position would behave better. We resorted to a light facing to realize a stronger bond in the metal engaging sand, and consequently attain a stronger mold and a more uniform casting. We carried a large center vent hole through the entire core and cope of the mold to the atmosphere to give gases a free and untrammeled avenue of escape and to allow further for the yielding of the core under the strain of the metal contraction. We poured hot because cold metal never will give an assuredly clean, solid casting. We rammed the core of the last three sections with the pattern of the mold to escape disturbing the part already rammed.

Bill Claims That Curiosity is An Asset

(*Concluded from Page* 554)

authority in the shop than you do at home I know just how long you would hold your job."

"I plainly see," said he, "that you are not willing to listen to my argument; but when I start something I like to finish it. I know a foundry where the iron formerly was hoisted to the charging platform in the same manner as it is taken up to the charging platform in hundreds of other foundries. That is, six or eight men wheeled it in barrows from the stock pile to an elevator. This elevator is operated by air or steam and carries the men and barrows up to the platform. Here the loads are dumped on a platform scale. Even when men were plentiful, it was difficult to get them to stay at this kind of work. When the war came on and the surplus of men was reduced to a deficit it became an acute problem how to keep the cupola supplied with iron. Now, according to your theory, nothing could be done. The jig was up. Shut her down.

"Did they do that? They did not. Never mind who thought of the scheme, I've heard every one from the foundry foreman to the chief engineer claim credit for it, but anyway a gang of riggers came along one day and erected a boom derrick within swinging reach of the charging platform. They put an electric hoisting drum on one end of the cable and a magnet on the other and now one man can swing up more iron in a day than the furnace can melt."

"Why," I said, "that magnet idea is old. I saw one in use the other day lifting castings into a gondola; they have them everywhere."

"Maybe it is," said he, "but I never heard of any one putting up their furnace charge with one and I don't believe you did either."

"Well, no," I said, "I did not, but I wish I had a derrick in my cellar with a grab bucket hanging to it. The missus has the life pestered out of me to shovel out last winter's ashes, and I am just about out of excuses."

"Don't be such a tightwad," said Bill. "Hang up a dollar bill where the young fellows can see it. Then announce that there will be a great ash pitching tournament held during the week, the dollar to go to the one who survives. I bet there will be a stream of ashes flying out of your cellar window some night that will make your neighbors think there is a rotary snow plow running around loose like a wild cat down there."

How and Why in Brass Founding

By Charles Vickers

Pickling Solutions for Nickel Castings

We would like to obtain some information relative to the character and strength of the acid pickling solutions used in removing oxide from nickel or cupronickel castings.

Solutions can be used similar in character to the ones adopted for rolled nickel. A pickle often used consists of 8 parts water to 1 part commercial sulphuric acid. A more modern idea is to incorporate bichromate of soda with this pickle of water and sulphuric acid. A solution of this type follows: Water, 44 gallons; sulphuric acid, 50 pounds; bichromate soda, 6 pounds. Dissolve the bichromate in the water as much as possible, add the sulphuric acid gradually stirring continually with a glass rod, or a piece of hard wood, as the water heats proceed more slowly with the addition of the acid. All the bichromate will now dissolve, and if the solution turns the castings black add more water. It is necessary to add more bichromate from time to time as the solution weakens, and about half the above quantity should be added, to a bath of the above proportions.

Making a Muntz Metal Mixture

We have received an inquiry for Muntz metal. Kindly let us know what is added to make it tough. Can it be cast successfully without the addition of aluminum, especially if scrap is added? We note occasionally that yellow brass castings do not contain aluminum; can you inform us how this is taken care of?

Muntz metal varies in composition and alloys are made with from 56 to 63 per cent of copper and 44 to 37 per cent of zinc. One of the Muntz patents claims 3.75 per cent lead; 40.25 per cent zinc and 56 per cent copper. When tin is added it becomes naval brass. If it has to be *toughened,* add 1 per cent or less of 30 per cent manganese copper. When iron is added it becomes Aich or Sterro metal. One per cent of iron, added in the form of tin plate, will improve the alloy.

Mixtures containing 40 per cent of zinc are more difficult to cast than yellow brass, but the addition of a little iron or manganese improves them in this respect; many castings of such alloys have been made without aluminum by adding enough iron or manganese to secure a slightly brownish color on the castings. It requires skillful molding and pouring. The addition of 0.10 per cent aluminum simplifies the casting process. The addition of aluminum makes the castings leaky; therefore, it cannot be used for pressure work and in this case it is customary to lower the content of zinc to approximately 25 per cent and sometimes less; use a little tin as a hardener and a small amount of lead to insure easy machining qualities.

Yellow brass was cast for many years before aluminum was known as a foundry product and no skilled yellow brass melter would think of using it, as it would be a reflection on his ability.

Making Casket Hardware

We would like to know how casket mountings are made, whether they are cast in permanent iron molds or in sand molds, and what kind and quality of metal is used in these castings?

Casket hardware is made of antimonial lead and it is finished by being given a thin plating of silver. The castings are made in dies and as the art of making die castings is a highly specialized industry it would be well to investigate the subject thoroughly before attempting the manufacture of these castings. About 50 years ago casket hardware was made in sand molds and was cast from alloys containing such metals as tin and bismuth but this is no longer the case and the sand castings would be unable to compete with the highly finished die castings.

Coating Iron with Tin

We have a few small pieces of iron we desire to coat with tin and would like to know the proper method of doing this.

To tin iron, first clean the surface of the latter with caustic soda solution if it is greasy, or with dilute hydrochloric acid if it is blued. Remove all scale by mechanical means then treat the cleaned surface of the iron with zinc chloride solution, or soldering salts and rub on the tin with a soldering iron, or immerse the cleaned iron in a bath of molten tin.

Pouring Temperature is Important

We are making needle valve castings for acetylene welders, and have been using an alloy of copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent. The mixture is not a success, however, as the castings leak under pressure, and we would esteem it a favor if you could assist us with a better mixture.

The trouble with leakage is probably due to pouring the metal at the wrong temperature. The best pouring temperature for 88-10-2 alloy is around 2200 degrees Fahr. It would be well to pour some castings at this temperature and test them as this may possibly remedy the difficulty. The following mixture, however, may be more satisfactory: Copper, 87.75 per cent; tin, 6.50 per cent; zinc, 2.50 per cent; lead, 2 per cent; 15 per cent phosphor copper, 0.25 per cent. Charge the phosphor copper with the copper part of the mixture, placing it in the bottom of the crucible and use plenty of charcoal on top of the copper as it is melting.

Treatment for Reclaiming Dross

Please advise where we may be able to obtain information in regard to deoxidizers for babbit dross and galvanizing dross. Any information you may be able to furnish bearing on these subjects will be appreciated.

It is not possible to deoxidize these drosses after they have once formed. To recover the contained metal the babbitt dross is passed through a refining furnace in which a combination of high temperature, carbon and suitable fluxes sets free the metal just about as was done in the case of the original ore. Zinc, however, is not set free from its oxide so readily and cannot be reduced to metal in open furnaces. It must be distilled and condensed which is done by strongly heating the oxide with carbon in closed retorts. Any zinc dross formed, therefore, cannot be treated for recovery of the contained zinc provided it is in the form of a powder. What is termed galvanizer's dross, however, is merely an alloy of iron and zinc which sinks to the

bottom of the kettle and is removed from time to time. It is an alloy of zinc with upwards of 3 per cent of iron which makes the zinc thick. This thick zinc is refined by melting it in a kettle, getting it sufficiently hot to be quite fluid and then introducing by means of a phosphorizer a crucible material a small quantity of a mixture of chopped potatoes, sulphur and leather. The dross rises to the top and is skimmed off, and the iron forms a sulphide matte which sinks to the bottom of the kettle. The operation is repeated several times and the result is the zinc is purified of the iron. As the zinc is now oxidized it is deoxidized by the introduction of aluminum, about 0.001 per cent being sufficient. This method produces an excellent grade of zinc that will run under 0.25 per cent of iron and will be over 98 per cent pure.

The excessive formation of dross on both babbitt and zinc kettles can be avoided by the use of such fluxes as rosin for the babbitt and sal ammoniac for the zinc. These fluxes are simply scattered on the surface of the bath and operate by freeing the dross from its entangled metal thus permitting the dross to be skimmed off in a powdery form. This form of babbitt dross should be sold to white metal refiners. The use of sal ammoniac on molten zinc will not prevent the formation of thick, or irony zinc, it only prevents metallic zinc being skimmed from the top of the bath with the dross.

Facing Materials Under Suspicion

We are sending for your inspection two samples of aluminum cut from two separate thin castings and showing defects in the form of isolated holes ranging from the size of a pinhead, as in the smaller piece, to irregular shaped cavities, about ¼-inch square, as in the larger sample. These holes are not due to wet sand as we have experimented by facing a mold with lumps of wet sand and strange to say, the casting came perfect. We have molded the castings in coarse sand, but they came filled with sand specks, so we now use Albany sand. We did use scrap aluminum and, blaming that, changed to all new metal with exactly similar results. The alloy is No. 12, copper, 8 per cent and aluminum, 92 per cent. Any suggestions you may make will be greatly appreciated.

An examination of the samples shows on one side a hole of a size that may vary in different samples. On the other side there are no signs of the hole, but there is an area of roughness with the sand burned on the casting. This rough area varies in shape with that of the hole on the opposite side but, having the hole as a center, it spreads over a comparatively large area of the casting. This shows there has been a localized disturbance of the aluminum while it lay molten in the mold. This disturbance was in the nature of a reaction between the aluminum and some substance that liberated heat and raised the temperature of the metal at this point and caused it to burn into the sand, or else the foreign substance caused the aluminum to bubble and simmer and thus eat away the sand in the vicinity, thus making a rough spot to which the sand could adhere. Probably both these actions occurred together.

The trouble, therefore, is either due to foreign particles in the sand itself or to some substance that is dusted onto the molds. If the action was caused by some substance that entered the mold with the metal it would be difficult to account for the reaction taking place in the mold, because the aluminum would have cooled from its furnace temperature in its transference to the mold and the reactions between aluminum and oxides or sulphides are favored by high temperatures. The reaction, for instance, between iron oxide and aluminum takes place only at high temperatures, so in order to bring about such a reaction it is necessary to use an igniter that will inflame easily and in so doing produce a very high temperature. It is doubtful, therefore, whether the aluminum could react with anything in the sand as its temperature would be too low to favor such action, but it is well to bear in mind this is a possibility. First, however, it would be advisable to investigate the molding operations to discover if the molds after being finished are dusted with a parting material, or whether the parting is allowed to stay on the pattern after the joint of the mold has been made previous to ramming up the cope. Commercial foundry partings are not intended as facings and it is possible the one being used contains organic matter that is consumed by the heat of the aluminum and produces a gas. In the case of the large sample with the large hole, as this occurs at the bottom of a depression it is possible the parting has been washed to this point by the stream of metal and being surrounded had burned away producing a gas that had held back the aluminum, thus producing a hole. The appearance of the piece of casting would favor this view as the burning of organic material at this point would produce a simmering of the molten metal that would cut the surface of the mold in the cope, precisely as this has done. We suggest an investigation of the methods of molding as far as the use of a facing or dusting of the mold is concerned. If such has been the practice we recommend that it be discontinued. Dust the molds with talc and if the sand sticks to the patterns dust on a thin coat of fine sharp sand.

Aluminum Alloy is Recommended

We would like to know how to mix facing sand for aluminum castings. Please also let us know of a suitable mixture for aluminum castings.

If a fine grade of brass molding sand is used, no facing is required for aluminum castings, nor for brass or bronze castings up to 100 pounds weight. For very large castings in dry sand a facing may be used consisting of molding sand from pile, 2 parts; new molding sand, 2 parts; sharp sand 1 part; mix thoroughly and add 1 part flour or dextrin to 25 parts mixed sand then wet with weak molasses water.

One of the best alloys for aluminum castings is what is known as No. 12 alloy, consisting of aluminum, 92 per cent and copper, 8 per cent. If thin sheet copper is available, use it for adding the copper to the aluminum. Melt a portion of the aluminum charge and bring it to a red heat, then add the copper and when it is dissolved add the balance of the aluminum. Another way is to first make a hardener by melting any amount of copper and adding gradually an equal weight of aluminum. Then melt 84 pounds of aluminum and add 16 pounds of the hardener.

Difference in Composition of Phosphor-Bronze

We would like to obtain the formula for Elephant brand of phosphor bronze.

The following is the analysis of a phosphor bronze intended for use where strength was required; copper, 90.58 per cent; tin, 8.86 per cent; phosphorous, 0.56 per cent. If the bronze is to be used for bearings, it should be leaded. For strength the lead is omitted. Elephant brand like all other phosphor bronzes is either leaded or not according to the purposes for which it is used. If for bearings the following alloy will approximate it very closely: Copper, 79 per cent; tin, 10 per cent; lead, 10 per cent and phosphor copper, 1 per cent.

Marine Gasoline Engine Cylinders

Problems Encountered in the Marine Engine Shop Tax the Ingenuity of the Foundryman — Copper Chaplets Recommended — They Resist Sea Water Corrosion

BY R. H. PALMER

GASOLINE-engine cylinders for marine use are neither so complicated in design nor delicate in structure as their aristocratic first cousins of the automobile. They should, therefore, be much easier to make. Under equal circumstances they would be. But within the past few years the methods of producing automobile cylinders have been improved so much, owing to the enormous demand, that types of cylinders which would not have been considered possible a few years ago are now turned out as a matter of course.

The demand for cylinders of the marine type has not been so heavy and there are no huge shops devoted exclusively to their production. Therefore, the methods employed for making them have not reached the same high state of development.

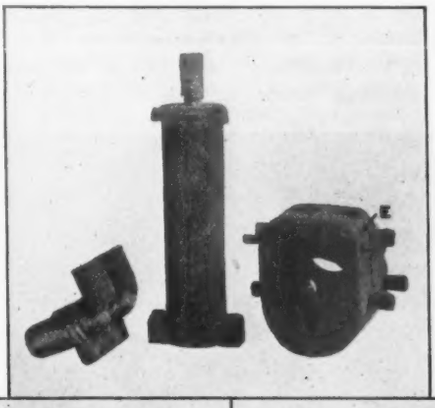
Nevertheless, marine-engine cylinders must measure up to exacting requirements and there are certain basic features to be considered in their production. They must be strong, light, homogeneous and free from defects of any kind. In order to meet these conditions it has been found necessary to preserve as nearly as possible a uniformity of thickness in the walls and also to see that the proper grade of iron is melted and poured at a high temperature.

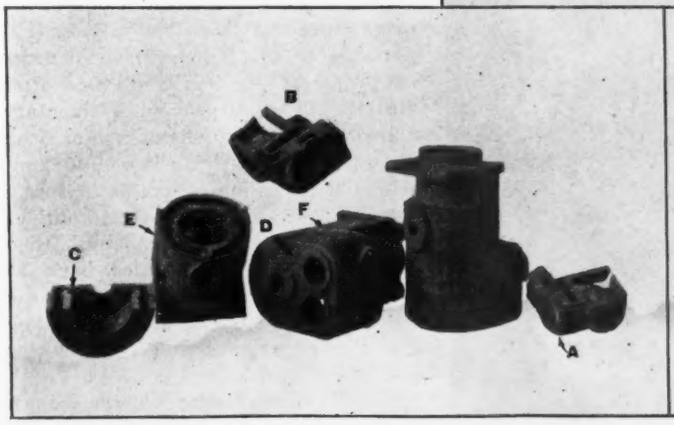
The thickness of metal in the barrel is always greater than that in the jacket. This is to allow for machining. If the disproportion is too great, or if the metal is too hard, the walls of the jacket will crack or draw away from the barrel. For in addition to being thicker than the jacket, the barrel wall, retained as it is between the barrel and jacket cores, holds the heat longer than the jacket. In order to overcome this trouble, the metal thicknesses are made as nearly uniform as possible, although as just stated some variation must be allowed. In some cases cast-iron chills are rammed up with the main core, dried with it and blacked. These help to cool the barrel walls and also have a tendency to close the grain of the iron.

Which is Better?

The relative merits of hard or soft iron for cylinders has been a moot point in the past among steam-engine builders. Those supporting the latter contention say that cylinders made of soft iron soon become glazed from the action of the piston and naturally work easier than those made of hard iron; but the others claim that a cylinder made of soft iron is almost certain to be spongy. Strong iron as hard as can be machined seems to give the best satisfaction in cylinders for marine gasoline engines. It must be strong because the engine has to be made as light as possible; it must be hard, of fine close-grained iron, to withstand wear. The transverse breaking strain of the iron in these cylinders should be between 3300 and 3600 pounds when the test is made on the American Foundrymen's association standard arbitration bars.

All foundrymen want to produce sound and perfect castings; they also wish to have these castings smooth and pleasing to the eye. Dry-sand molds will give cleaner and smoother castings than green sand but it is a more expensive method and is only used on the larger sizes of marine engines. If fine close sand could be used, the green sand would give just as smooth a skin; but unfortunately the very fineness of the sand interferes with the gas escaping from the mold. Mechanical analyses of molding sands indicate that the voids in fine sand are relatively larger than in that of coarser grades, but actual practice demonstrates the fact that the gases escape more readily through coarse sand, and therefore sounder castings are produced with this material. The sands used for cores are usually lake or beach sand because





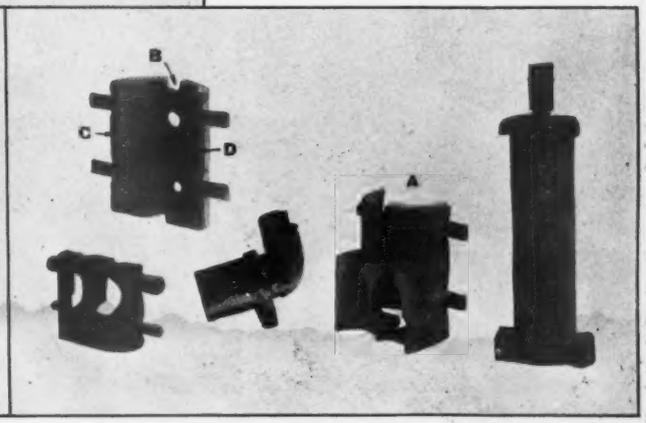


FIG. 1 (LEFT)—CASTINGS SAWED APART TO SHOW METAL THICKNESS FIG. 2 (ABOVE)—JACKET CORE, ON THE RIGHT, SHOWING HOLES FOR CLEANING OUT CORE FIG. 3 (RIGHT)—A COMPLETE SET OF CORES BEFORE ASSEMBLING

a clean washed sand is one of the prime requisites of success on the jacket and smaller cores. The barrel core may be of different sand. Washed sand gives the best results; it is free from clay and other foreign matter which only serve to absorb binder. This sand analyzes nearly 90 per cent silica; therefore cores made of it resist the intense heat of the iron without fusing. There is no need of blacking them as they are easily cleaned out and leave a very smooth surface.

Oil binders are generally used on this class of work. When the proper proportions of oil and sand are used, a very strong open core is the result, requiring very little rodding; the venting is nearly automatic and the gas escapes very readily. Gratifying results are obtained from a mixture consisting of one part of oil to 45 of beach sand. In order to obtain cores true to size it is advisable to use metal dryers. In assembling the cores skilled workmen and constant supervision are necessary.

Making the mold also requires constant attention not only in ramming the sand but in setting the cores and arranging for the escape of the vent. When pouring the castings it is essential that the iron be poured at the proper temperature; also it is advisable to provide safeguards which will prevent anything but clean iron from entering the mold. Cold iron seldom produces clean cylinders and it does not pay to take chances.

Fig. 1 shows two cylinders, two views of the same type being shown in the center. On either side are pieces of a third cylinder which has been sawed apart to check up the thickness of the walls in the different sections. Thus by placing *A* and *B* together with *C* at the left we have cylinder shown at *D*. Place *E* and *F* together and we have the cylinder shown in the center.

Fig. 3 shows a set of cores; *A* and *B* are jacket cores, *A* forming a part of the lower half of the jacket with *B* set on top of it forming the jacket around the cylinder barrel.

All founders are aware of the wedging strain of iron and how it finds its way between two cores. It is very important that this does not take place in these cylinders. There must be an uninterrupted circulation of water around the barrel while the engine is running; therefore the two half cores for the jacket must be brought into intimate contact along the joint. To achieve this, a thin mixture of putty is applied to the joint of the core; or flour mixed with oil may be used. In some of the larger sizes a putty worm is laid between. On the largest sizes the joint of the jacket core is usually filled with sand and dried with a torch.

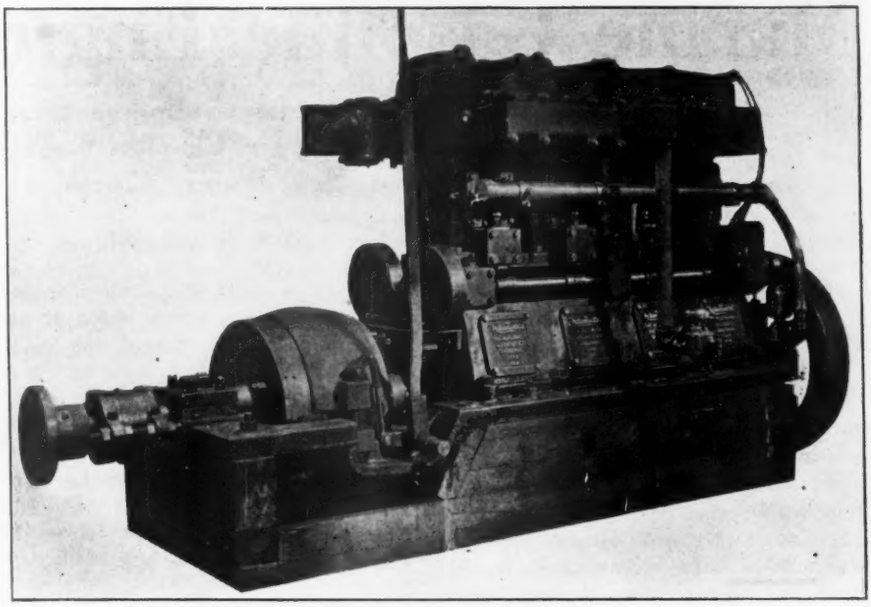


FIG. 5—THE ENGINE COMPLETE

FIG. 4—SOME OF THE CYLINDER CASTINGS

Nearly every foundryman making this class of work has his own special ideas about the proper mixture of iron. At times they fail him. Few foundrymen are chemists and few chemists are foundrymen. Each may be competent in his own line. If they will work together and cooperate, each will find his work made easier and the results of their joint efforts will be gratifying. The work of the chemist is of the utmost importance to the foundryman. In order to profit by it, however, the latter must have at least an elementary knowledge of the chemistry of iron and steel otherwise he may find himself in the position of the patient who emptied the bitter contents out of some capsules before taking, then carried the empty capsules back to the doctor and said, "Don't you know it's dangerous for people to swallow glass?" Experience is often a bitter pill.

Fig. 4 shows some of the rough castings in the cleaning room. As we have no sand blast, they are rumbled. In the sides of the cylinder

small holes may be seen. They are for the purpose of removing sand and rods, and are afterward plugged. At the point marked *E* in Fig. 2 may be seen the reinforcement in the core which provides the extra thickness necessary for this purpose. The jacket core goes in the mold the opposite way from which it is shown assembled in Fig. 2. The holes shown at *B*, Fig. 3, are for the purpose of letting the iron flow in from the inside to meet and join with the iron flowing from the outside, thus avoiding cold shuts.

Copper Chaplets May be Used

Steel chaplets should not be used in marine engine work. The salt water soon corrodes them and leaks develop. Copper rivets will prove satisfactory on light cylinders with thin walls. It is not necessary to make the stem of steel. Take a steel or iron rod and bore a hole in the end, in this insert the copper rivet or nail. If the iron is good and hot it will partly fuse the copper and make an absolutely tight joint. Fig. 5 shows an engine assembled and indicates what the engine looks like when the castings have all been assembled and set up on foundation blocks ready for testing under water pressure.

Preventing Accidents With Ladles

BY M. H. POTTER

IN almost all casting plants the general hazards of foundry operations are carefully guarded against; the unusual hazards, however, are liable to escape notice and it is for the purpose of preventing accidents from such hazards that these suggestions are made.

Bull or double-handled ladle bowls should be so balanced on their trunnions that they will remain erect regardless of the amount of metal which they contain. A top-heavy ladle is a menace, while a ladle provided with an excessively heavy bottom strains the operating mechanism unnecessarily and makes smooth pouring difficult. Ladle shanks should be of sufficient strength for the purpose for which they are intended, and since the strain usually is greatest at the joint, these should be securely welded. The shanks should be inspected periodically for flaws which may develop in the welds, or for other weaknesses caused by erosion of molten metal or by wear. Discarded ladle shanks should be scrapped immediately and defective shanks should be promptly removed and repaired. Also, ladle shanks should be protected from rust in storing.

The shanks should be securely attached to the bowls of single-handled ladles when practicable. Ladles with detachable bowls that are liable to slip out of their shanks when upturned, although requiring less storage space, are not safe for handling metal. Whenever detachable bowls are used, they should be made a wedging fit into the shank rings and they should be balanced to prevent the tendency of the bowl to fall out when tilted. Care should be exercised in fitting the bowl in the shank rim to prevent cracking the lining. A rigid fork at the opposite end of the bull ladle shank will enable molders to carry and empty the bowl more evenly than when both ends of the shank are rigid. The man pouring at the swivel end does not interfere with the control of the ladle by the man at the rigid end of the shank. Iron straps should be employed to hold the bowls securely in their shanks.

Ladles equipped with operating mechanisms should be so constructed that they cannot be turned over accidentally. None of the strain of controlling the metal flow should be borne by the operator. Due to the rapid wear of gears and pinions, they should be inspected at regular intervals. To avoid confusion, all mechanically-operated ladles in the shop should turn in the same direction when pouring. Gears, pinions, hand wheels and trunnions which are liable to work loose, should be held securely by tapered pins, lock washers, double nuts or set screws. Gear covers, readily detachable for inspection purposes, should be provided. Means for fixing the ladle in an upright position while it is being conveyed to the pouring floor or at rest, also should form a part of this equipment. A device of this kind will prevent rocking or upsetting the ladle.

Lining the Ladles

The work of lining ladles should be entrusted to one capable man. It is neither desirable nor safe to permit each molder to line the ladle bowls which he uses since, as a rule, he prefers a light ladle to a safe one. Furthermore, if this work is delegated to one man, he soon becomes expert in the task. The drying of ladles always is an important safety factor. Special ladle heaters are desirable for this work and are used by many foundries. However, large core ovens or crucible furnaces also may be employed. Since the contact of molten metal with a moist lining may result in an explosion, ladle linings should be thoroughly dried. However, the ladles should be supported above the ground a sufficient height to provide ample air space between the bowl and the ground to prevent the absorption of moisture. Ladles not only should be inspected regularly when not in use, but a watchful eye should be kept on the linings while in the service to detect thin spots or breaks.

Dangerous spattering of metal will be avoided when filling hand ladles from a continuous stream by cutting into the stream from the front instead of the back.

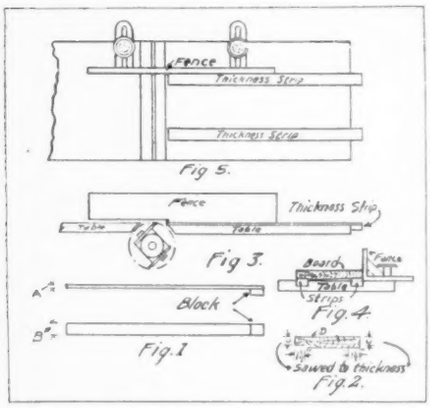
The workman should use a rod to guide the crane hook into place when it engages the ladle; this will enable him to stand at a safe distance from the molten metal. The bail of the crane ladle should be raised to a vertical position and hooked in place and the crane hook should hang directly over it. These details require a little time, but will prevent accidents.

A novice never should be entrusted with the pouring of metal from crane ladles, nor should a recently employed molder be permitted to carry ladles of molten metal until he has been around the shop several weeks and has familiarized himself with existing conditions. When carrying a hand ladle the workman should keep the bowl behind him. At pouring-off time, when many men are carrying hand ladles simultaneously, it should be a rule of the shop that they should pass each other on the bowl side. When pouring, the molder should keep his feet as far away from the mold as convenient to prevent burns from a runout.

The inspection of crucibles should be critical and should begin when they are received. Only such pots as are found to be in sound condition should be placed into service. Crucibles which have become wet in transit should be returned, since moisture in a crucible is a source of great danger when the pot is exposed to high temperatures. All crucibles should be dried out before they are charged. The top of a continuously-operated core oven is an ideal place for storing them. Also, waste gases from furnaces or from ovens may be employed advantageously for this purpose. Such gases, however, should not come into direct contact with the crucibles to deteriorate them.

When annealing crucibles they should be heated slowly and uniformly to dull redness and they should be prepared for annealing by heating them to a temperature of about 220 degrees Fahr. To prevent the absorption of moisture by crucibles after annealing, they should not be allowed to cool before charging.

When subjected to melting temperatures, crucibles become soft and pliable and are easily deformed by concentrated pressure. The slightest deformation of the pot is liable to develop cracks when a crucible cools. Therefore, crucible bottoms should be kept free of clinkers and they should be set on well-prepared fuel beds. A firebrick bed is recommended for this purpose. The metal should be charged loosely to prevent wedging, or otherwise the expansion of the metal will strain the crucible walls. If a crucible is not to be recharged immediately after pouring, all of the metal should be poured out as it will contract when cooling and is liable to weaken the crucible base.



DETAILS OF DEVICE USED ON JOINTER FOR PLANING WARPED LUMBER

Planing Warped Lumber on a Jointer

By William Ballantine

Warped lumber is common enough in a pattern shop and it is often a problem to find the best way to straighten a twisted board; to get it even and uniform in thickness when there is no pony planer available.

With the aid of the device shown in the accompanying illustration, warped lumber may be planed up true on an ordinary jointer. Fig. 1 shows a detailed view of the strips on which the board rests while passing across the knives. The strips are usually from ¼ to ⅜ inches thick and about 1½ inches wide; the length will correspond to that of the rear table of the jointer. The blocks drop over the end of the table and thus prevent the strips from sliding into the knives.

Since these strips are to form part of the regular shop equipment and in all probability will be used frequently, it will be well to make them of good material and see to it that the blocks are well secured.

Before attaching the strips to the table, the lumber to be straightened is passed across the jointer and one side trued up, *D*, Fig. 2. It is then taken to the rip saw and the gage set about 3/32 inches in excess of the finished thickness. The saw is adjusted to 1½ inches and a strip taken off each side as shown at *C*, Fig. 4. The straight surfaces thus provided act as guides and rest on the strips previously referred to and shown by the dotted lines in the same figure.

A side view of the machine with the strips in position is shown in Fig. 3. It will be also noted in this figure that the rear table is lowered until the tops of the strips are about 3/32 of an inch below the level of the front table, thus allowing the knives to cut clear across the board and leaving an even surface on the board.

Fig. 4 shows an end view of the jointer with board in place on the strips. The strips provide clearance for the uneven part of the board and act as parallels on which the sawed part slides.

Fig. 5 is the top view of the jointer and shows the strips in place. They may be adjusted to any width of board as they are not fastened in any way to the table, the blocks at the end and the sawed part of the board holding them in place.

This method may also be employed for putting draft on boards by sawing one edge of the board thicker than the other. In fact the idea may be adapted, amplified and improved upon in many ways that will occur to the practical patternmaker.

Be sure to raise the rear table to normal position each time when through using those strips. It is extremely dangerous to go away and leave a jointer set for such a heavy cut.

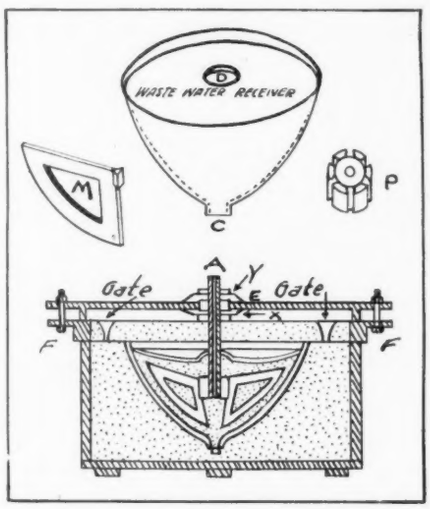
Collapsible Arbor for Waste Water Basin

By J. R. Anderson

The class of castings known as hollowware afford an interesting opportunity for the foundryman to exercise ingenuity in devising rigging for economical production. All of this work, which has a thin metal sections, is made in green sand and generally in large quantities; which means that the rigging must be accurate and substantial. Furthermore since the openings in some of the castings are much smaller than the body of the core it follows that some form of collapsible arbor is required; otherwise it would be necessary to break the arbors in order to remove them and a new set of arbors would have to be provided for each lot of castings.

The style of arbor used and the method of molding one of these castings is shown in the illustration.

The rigging for making and securing the core is shown assembled and in detail. *A* is a piece of gas pipe threaded at each end; *P* is the hub of the arbor and *M* is one of the wings; *E* is a strongback which extends across the cope. It is bolted to lugs, one on each side of the cope, and is provided with an opening in the center to accommodate the gas pipe. The latter is held in position by two nuts, one above and one below the bar. The top plate of the pattern is loose in order to facilitate the molding.



MOLD FOR WATER BASIN

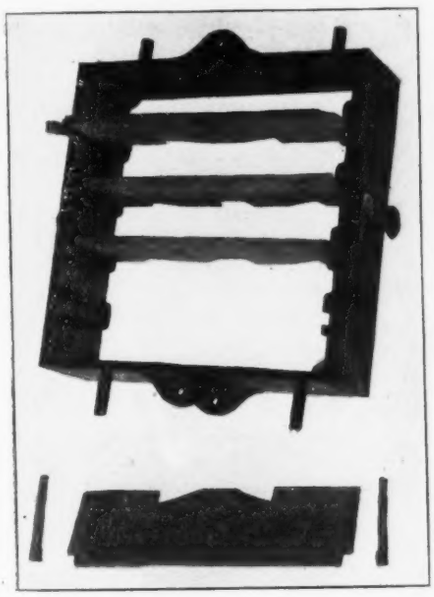
To make one of these castings the molder lays down his roll-over board and drag with the pattern centered. He rams the drag and rolls it over, makes his parting and lays a layer of sand about ¾-inch in thickness up all around the inside wall of the pattern. He then assembles his arbor by dropping the ends of the wings into the slots in the hub. They are always a loose fit and are tightened up by driving wooden wedges along side of them. The gas pipe is next screwed in, the arbor is set into the pattern and worked down into the thickness of sand previously referred to. The sand is tucked with the fingers until the pattern is full then the cover plate is put on and the cope rammed. The gas pipe is next taken out and the cope lifted off. After drawing the cover plate of the pattern the cope is replaced, the gas pipe screwed into the arbor again and the lower nut *X* run down until it touches the sand. The strongback *E* is then dropped on and bolted to the lugs *FF* after which

the nuts *X* and *Y* are screwed firmly against the bar *E*.

The nut *Y* is to hold the core up after the pattern has been removed and the nut *X* is to keep the core from lifting with the pressure of the molten iron.

After assuring himself that everything is secure the molder lifts the cope off again and this time the core comes with it. He places it on a pair of horses while he is drawing the pattern and cutting the gates. It is then replaced and when the flask is clamped it is ready for the iron.

When the casting has been poured and cooled off, a little rapping will



FLASK WITH ONE BAR REMOVED

loosen the sand and wedges, the arbor can then be removed one piece at a time and reassembled.

Cope With Separate Bars

A loose-bar flask recently patented by T. F. Jennings, foundry superintendent for the Utah Copper Co., Garfield, Utah, is shown in the accompanying illustration.

Two sides of the flask are provided with pockets, wide at the top and narrow at the bottom into which the ends of the bars are dropped.

One side of each pocket is straight or perpendicular to the joint and carries a shoulder at the top. The other side is on a slant. After the bars are in place a wooden wedge is driven back of each to keep them in place. The stop in the bottom of the pocket keeps the bar the right distance from the joint and the shoulder on top prevents the bar from falling out when the cope is rolled over.

The advantages claimed for this style of flask are that by substituting different shaped bars a wide variety of jobs may be made in the same cope. Contraction and expansion of the frame and bars will be independent of each other and therefore there will be no danger of rupture. In the case of steel castings the wedges may be removed and the frame lifted off leaving the bars with the casting. If a bar breaks it is easily replaced. Any person can fit it up, the only tool necessary being an ordinary hammer.

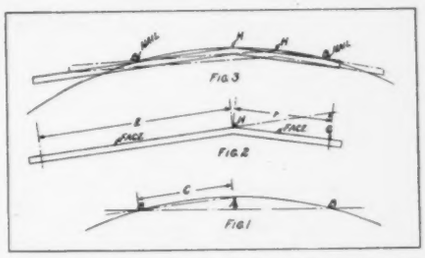
Buying Grindstones and a Word About Hones

By M. E. Duggan

Recently a patternmaker went into a hardware store to purchase two slip stones, the one for quick and the other for flat radius gouges. He was informed that none of the stones were in stock and that probably six months would elapse before they could be obtained. This patternmaker related his experience to me and explained that he had in his tool kit three fine hones intended for flat tools only, but I explained to him how I shaped the one and only hone I possess to be used for honing both round and flat tools.

The dimensions of the hone are ⅞ x 2 x 5½ inches. The two ends and a side elevation are shown in the accompanying illustration. At the left is shown the one end shaped to take a flat curve for flat gouges. One corner of the hone, beginning at the end, is tapered gradually and rounded down to the other end on about a ¾-inch radius. The best hone obtainable should be selected for this purpose and when properly shaped will serve for shaping tools and gouges, both large and small.

In this connection I want to say a word about the purchase of grindstones. I selected the stone in our department because of its cutting qualities and because of its truth on the sides as well as at the periphery. This stone revolves as true as it it were turned in a lathe and has all the qualities to be desired in a good cutting stone. A stone of this kind costs no more than one that does not possess these desirable qualities. The sides of the stone are used for truing and shaping hones, slip stones and for truing the flat faces of cutting tools. Some patternmakers wait until their hone becomes worn about 1 inch before truing up. This is a mistake. Whether worn, hollow or flat, I touch



METHOD USED IN LAYING OUT ARCS OF LARGE CIRCLES

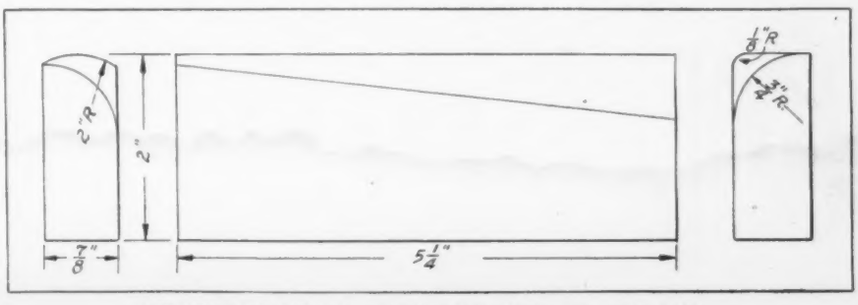
up my hone about twice weekly and I notice immediately an improvement in cutting qualities.

Device for Making Segments

By William Ballantine

Considerable trouble is frequently experienced in getting out stock for segments of large circles. The method illustrated in Figs. 1, 2 and 3 is a quick, easy and accurate way of doing this work on the bench. Fig. 1 shows the arc of a circle for which it is proposed to make a pattern. We will assume it is drawn to a certain scale.

The first step is to draw a chord from any two points *B B*, Fig. 1. Bisect this chord and scale the distance *A* and also *C*. These measurements are important and must be accurate to insure results. The next step is to make a template as outlined in Fig. 2. The important feature of the template is that all measurements are to be full size. Thus in this case, *F* will be the same length in feet as *C* is in inches; *E* will be twice as long as *C* and *G* will be twice the height of *A* in the same proportion. This relative proportion remains the same no matter what scale is used. In other words, *E* is always twice as long as *C*, *F* is the same length as *C* and *G* is exactly twice the height of *A:* Always remembering that the measurements on the template are to be full size.



SLIP STONE SHAPED FOR HONING BOTH ROUND AND FLAT TOOLS

THE FOUNDRY

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Apply Reciprocity in Foundry Work

THE old political slogan of a bygone campaign, *reciprocity is the life of trade,* is not only true in the limited sense of trade between countries, but it is also true in trade between concerns in the same country, and between individuals and corporations and between individuals' themselves. Not only is it true in the more general sense of the word trade, but in the very broadest sense of that word, which in its deeper meaning reaches to the very basis of human relationship and activity. In the early days of the ranchmen reciprocity was an unwritten but generally acknowledged rule and one ranchman would look after the interests of another as though they were his own affairs. Even now in the country when a farmer has a barn to raise the neighboring farmers come to help him in the work without charge, but the farmer's wife prepares a good meal and there is a sociability which makes the work seem lighter. This same sociability is applied in a similar way in modern corporations to promote fellowship among the employes. And the other side of the reciprocity idea is also in evidence to some extent. But it is not nearly as freely or as broadly applied as it should be. The foundry business has been greatly benefited by the information given out in technical papers. But this has been too one-sided to be termed reciprocal. A certain few have given liberally of their experience while others have withheld information which would have benefited the foundry industry in general. The man with ability and resourcefulness cannot be handicapped by information he might give out because he himself is continually advancing and developing his practice and perfecting his organization.

A large number of concerns do not hesitate to show visitors through their plants and answer questions. The visitors as a rule are men at the very tops of their organizations and foundry foremen on the other hand have little opportunity to visit other works. The question is whether it would not pay a firm to encourage its foundry foreman to visit other progressive foundries occasionally. The general manager of a German foundry a few years ago emphatically said *no* to this question and added that it was not his business to educate foundrymen for other companies. Evidently he did not consider it a benefit to his interests to have his foundry foreman educated so he could take the initiative in introducing new methods into the foundry, but was content to have a man in charge of his general foundry operations who could follow more or less blindly the instructions of the man above him. But would it not pay to educate your foundry foreman as broadly as possible and give him the opportunity of visiting another progressive foundry occasionally? The foundryman frequently will gain more from such a visit than he could work out by himself alone in months of mistakes and ineffectual trials and the trip to the other foundry would be amply paid for. This same foreman might be able to give a tip to the foundryman he was visiting which would be of great help to the latter and the theory of reciprocity would be justified. Should the suggestion occur to you that the foreman might learn so much that another firm would offer him sufficient inducement to cause him to leave you, remember that with the man already in your employ, you have the advantage over your competitor and can keep your foreman if you pay him what he is worth.

Trade Outlook in the Foundry Industry

FOUNDRYMEN almost everywhere are finding orders so plentiful that the unused capacity yet remaining is rapidly being absorbed. The gray iron, malleable and nonferrous shops are the most active, although the steel foundries are beginning to pick up business in greater volume than was the case sixty days ago. It now seems certain that reconstruction prosperity has set in in earnest and that the sharp lull which was experienced earlier in the year was purely temporary and solely the result of the industrial shock from the sudden ending of the war.

Prices Are a Factor

The price and labor factors are the most serious elements in the business situation surrounding the foundry trade at the present time. They are, of course, interdependent. Throughout the length and breadth of the land there is a justifiable clamor for lower quotations; nevertheless, the foundryman finds himself confronted with a stiffening market both for his raw materials and his labor. Pig iron is certainly showing no tendency to decline. For the first half of 1920, Chicago producers have, in fact, advanced their prices $2 per ton. This makes foundry iron $28.75, Chicago furnace. Practically the only business booked under this price, however, is for the purpose of covering on contracts for castings to be delivered during 1920, the prices for which have been definitely fixed. Chicago furnaces are almost sold up and an advance in prices for 1919 delivery is expected at any time. Conditions in the Middle West and East are also firm, although advances do not seem quite so imminent in those sections. Practically every blast furnace in the West will be in operation by Sept. 1. In several instances melters are known to be meeting this situation by buying sufficient pig iron for delivery during the last half of this year to supply a large part of their needs for the first half of next year. These foundrymen believe that prices will be materially higher. The demand for malleable pig iron has been especially strong, indicating heavy commitments by consumers of malleable castings. The market situation for raw materials is having its effect on the price of castings. Cast-iron pipe manufacturers have increased the differential between Class B and Class A pipe $2 per ton; in the past this premium has been $1 per ton. Coke is firm, especially in the West, where considerable interference with the manufacture and delivery of foundry fuel was experienced early in August on account of the strike of railway shopmen which caused an artificial shortage of cars and locomotives. Prices for castings are firm in all directions. In the Newark, N. J., district the average for gray iron continues at 5 to 7 cents per pound, although occasional instances still are noted where some melters are cutting this range. These prices are quoted only for early delivery and producers of castings are not inclined, under present conditions, to commit themselves very far in advance, at least not without adequate protection on pig iron. Eastern foundries which were operating at only 50 to 60 per cent of capacity a month or so ago, it is estimated, are now operating on an average of 75 per cent and the demand for tonnage is still increasing.

Prices of Raw Materials for Foundry Use

CORRECTED TO AUG. 10

Iron		Scrap	
No. 2 Foundry, Valley	$26.75	Heavy melting steel, Valley	$22.00 to 22.50
No. 2 Southern, Birmingham	26.75	Heavy melting steel, Pittsburgh	22.00 to 22.50
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	22.00 to 22.50
No. 2 Foundry, Philadelphia	29.00 to 30.50	Stove plate, Chicago	25.50 to 26.00
Basic, Valley	25.75	No. 1 cast, Chicago	28.50 to 29.00
Malleable, Chicago	27.25	No. 1 cast, Philadelphia	23.50 to 24.00
Malleable, Buffalo	27.25	No. 1 cast, Birmingham	22.00 to 23.00
Coke		Car wheels, iron, Pittsburgh	24.00 to 25.00
Connellsville foundry coke	4.75 to 5.50	Car wheels, iron, Chicago	27.00 to 27.50
Wise county foundry coke	6.50 to 7.50	Railroad malleable, Chicago	24.50 to 25.00
		Agricultural malleable, Chicago	24.00 to 24.50

Labor's Demands Heavy

From the employer's standpoint, the labor situation shows little tendency to improve. Most foundrymen are anxious for their men to be prosperous and comfortable and to this end are willing to pay the highest possible wages, but from a business standpoint, some stability in the situation is essential. Strikes are interfering with production in several centers, especially in the Chicago district, where walkouts have occurred in the plants of the Crane Co., the International Harvester Co., the Illinois Malleable Iron Co., and other foundries. The Harvester strike is indicative of the instability of existing conditions in that it took place in the face of the most earnest efforts on the part of the company to preserve harmonious relations and to bring about satisfactory working conditions.

Gray Iron in Demand

Gray iron foundries continue to be more active than other branches of the industry. Automobile and tractor manufacturers are consistent buyers of castings. Machine tool makers also are coming into the market. A material improvement is reflected along the middle Atlantic seaboard, in northern New Jersey, along the lakes and in the Central West. Activities in the gray iron shops are on a somewhat lower scale on the Pacific coast due to a gradual cessation of shipbuilding activities and in the metropolitan district of New York where foundries which specialize on structural castings are finding difficulty in obtaining enough tonnage to keep occupied. Cast iron pipe manufacturers are receiving good orders, especially for the smaller sizes of pipe. The nonferrous foundries also continue active. Prices of nonferrous metals have shown much more steadiness recently than during July and price changes since the first of the month have not been extensive. The prices on nonferrous metals based on New York quotations follow: Casting copper, 23.50c; lead, 5.75c to 6c; tin, 53.50c; antimony, 9.25c; aluminum, No. 12 alloy, producers' price, 31.50c; and open market, remelted, 28c. Zinc is quoted at 7.65c to 7.70c, St. Louis. The decline of tin is due to opening of trade routes.

Comings aud Goings of Foundrymen

HARRY M. GILES, who recently became general superintendent of the Westinghouse Electric & Mfg. Co.'s plant at South Philadelphia, Pa., succeeding Oscar Otto, was the guest of honor at a banquet given a short time ago at the Hotel Adelphia, Philadelphia, by officers and heads of departments. Mr. Giles, who is 50 years old, has been associated with the Westinghouse company since 1907. Prior to that time, he was connected with the Corliss Engine Co., in an engineering capacity. Before his recent promotion, he was superintendent of the marine erection department of the Westinghouse company.

W. H. Perry Jr. is in charge of equipping a small foundry for the Simmons Co., Kenosha, Wis., manufacturer of metal beds.

I. C. MacKie, who for a number of years was chief chemist of the Dominion Iron & Steel Co., Sydney, N. S., has been appointed metallurgist.

Q. S. Synder, of Chicago, recently was made vice president and treasurer of the Pittsburgh Rolls Corp., Pittsburgh, to succeed H. R. Warfield, resigned.

William H. Holt, who for the past four years has been assistant superintendent of the Woonsocket Machine & Press Co., Woonsocket, R. I., has resigned owing to ill health.

George Mesta, president of the Mesta Machine Co., Pittsburgh, recently sailed for Europe on a combined business and pleasure trip. He is expected to return in November.

Lieut. M. J. Carpenter, who recently returned from Archangel, Russia, where he spent last winter with the 339th infantry, has resumed his duties as manager of the Foundrymen's Supply Co., Inc., Milwaukee.

David S. Dobson and Llewellyn H. Davis, who recently were discharged from United States army service, now are affiliated with William Dobson, Canastota, N. Y., manufacturer of molders' tools.

A. H. Stolzenbach, secretary and treasurer of the Diamond Coal & Coke Co., will become affiliated with the organization of the Hillman Coal & Coke Co., Pittsburgh, which it is reported has acquired a controlling interest in the Diamond company.

H. G. Faskbinder recently was appointed foundry superintendent for the Stover Mfg. & Engine Co., which controls the Stover Engine Co., Freeport, Ill. He formerly held a similar position with the Minneapolis Steel & Machinery Co., Minneapolis.

R. C. Gosrow, who has been serving the North American Co., New York, as electrometallurgist, and the Pittsburgh Furnace Co., and the General Steel Co., Milwaukee, as sales manager, recently located in Seattle. He is engaged in electrometallurgical engineering work and metallurgical and industrial sales engineering.

W. T. Gregory, formerly pattern shop superintendent of the Michigan Motor Castings division of the General Motors Corp., Buick plant, Flint, Mich., has been promoted to be foundry manager. He succeeds W. H. Goldstein, who recently became gray iron foundry superintendent of the Nash Motors Co., Kenosha, Wis

Will H. Brown has been appointed supervisor of purchases and material for the Nordyke & Marmon Co., Indianapolis, succeeding J. H. O'Brien, resigned. Mr. Brown has recently returned from France, where he served as a lieutenant in charge of motor transport of base section 1, American expeditionary force.

D. B. Stokes, formerly eastern sales manager of the United States Cast Iron Pipe & Foundry Co., Burlington, N. J., has been made western sales manager with headquarters in Chicago. He succeeds A. J. Goodhue, who on Aug. 1 was made sales manager emeritus. W. G. Savage, assistant western sales manager, has been made eastern sales manager with headquarters at Philadelphia.

J. R. King, who recently became foundry superintendent for the Monroe Foundry & Furnace Co., Monroe, Mich., formerly held a similar position with the Liberty Foundries Co., Rockford, Ill. He has had 16 years experience in practical foundry work and has mastered many of its details. He also is a practical patternmaker and at one time operated a small foundry and pattern shop of his own.

M. J. Gregory, who for about three years has been foundry superintendent for Dodge Bros., Detroit, has been appointed to a similar position with the General Motors Corp. He will operate the foundry department of the new Samson tractor division, Janesville, Wis., when completed. At present, he is located in the main offices of the General Motors Corp., Boyer-Campbell building, Detroit. Prior to 1916, Mr. Gregory was affiliated with the Brown & Sharpe Mfg. Co., Providence, R. I.

R. R. Shafter has returned to the sales organization of the Traylor Engineering & Mfg. Co., which operates a foundry at Allentown, Pa., making castings for mining, milling, crushing and smelting equipment. For the past two years he has been general superintendent of the shipyard of the Traylor Shipbuilding Corp. Mr. Shafter will be New York district manager in charge of the Traylor company's office at 30 Church street, New York City.

Dr. F. G. Cottrell, chief metallurgist of the bureau of mines, who invented the Cottrell process for utilizing smelter fumes by extraction of arsenic and various other commercial chemicals from the escaping noxious gases, has been named assistant director in charge of all investigational and scientific work. F. J. Bailey, chief clerk of the bureau, becomes assistant to Director Manning in charge of executive work. J. E. Spurr, well known mining engineer of New York who, at the outbreak of war, became director of war minerals investigations and later was appointed chief of investigational work in connection with relief claims, has resigned to become editor of the *Engineering and Mining Journal,* New York. No successor to Mr. Spurr has been appointed.

F. B. Gerard, director of purchases and formerly the Indianapolis representative of the Austin Co., Cleveland, industrial engineer and builder, has resigned and is succeeded by F. W. Mettler. Mr. Gerard has been made general manager of the Pilkington Bros. Co., Ltd., Thorold, Ont., and on Aug. 1, left for a trip to the home office of the Pilkington company at St. Helens, Eng. After he becomes acquainted with the organization, he will resume his duties at Thorold. Prior to becoming affiliated with the Austin company, Mr. Gerard was manager of what formerly was the German-American Portland Cement Co., La Salle, Ill. Mr. Mettler, the new director of purchases for the Austin company, formerly was chief engineer for the Hunkin-Conkey Co., and later for the Crowell & Sherman Co., now the Crowell-Lundoff-Little Co. For the past 10 years however, he has been in business for himself, designing reinforced concrete buildings for industrial and other purposes.

Interests Are Consolidated

Prominent Foundry Equipment Manufacturers Effect Merger—Plan to Erect a New Plant in Cleveland

V. E. MINICH, of the American Foundry Equipment Co., New York, and Elmer A. Rich Jr., principal stockholder of the Rich Foundry Equipment Co., Chicago, have brought about the consolidation of their interests with the result that Mr. Minich becomes president and Mr. Rich vice president of the new organization which will be operated under the name of the American Foundry Equipment Co. This company now operates a plant at Cleveland, and has controlled the Sand Mixing Machine Co. and the American Foundry Equipment Co. for a number of years. He is also a director of the American Foundrymen's association and president of the Foundry Equipment Manufacturers' association. Mr. Rich is a director of the latter organization. He has been prominently identified with the manufacture of foundry equipment for many years. The new officers of the American Foundry Equipment Co. are as follows: V. E. Minich, president; E. A. Rich Jr., vice president; R. H. Kelley, secretary; O. A. Pfaff, treasurer.

Henry T. Hall, vice president, Merchants National bank, New York City, is also associated with Messrs. Minich & Rich in the new organization. Mr. Hall is a director of the American Foundry Equipment Co.

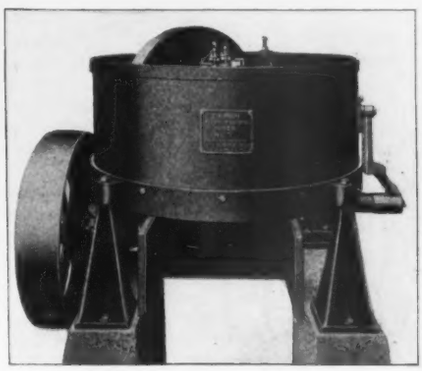
V. E. MINICH
President, American Foundry Equipment Co.

ing Machine Co. for some years. These three corporations are now consolidated under the name of the American Foundry Equipment Co., and manufacturing headquarters will be continued in Cleveland, with general offices at 52 Vanderbilt avenue, New York City. The Rich Foundry Equipment Co. manufactures sand blast apparatus, Hammer core machines, charging trucks for malleable foundries and other types of foundry equipment. The Sand Mixing Machine Co. and the American Foundry Equipment Co. manufacture sand cutting machines, sand blast apparatus of various types, and other devices. The Chicago plant of the Rich company will be moved to Cleveland and sites for a large new plant are now being examined. V. E. Minich has been in charge of the interests of the Sand Mix-

ELMER A. RICH JR.
Vice President, American Foundry Equipment Co.

Repairing Sternframe of Northern Pacific

The Metal & Thermit Corp., New York, has recently completed the largest marine weld ever recorded, on the cast steel sternframe of the U. S. army transport NORTHERN PACIFIC. The section welded was entirely broken through as a result of the severe strain to which the frame was subjected when this transport, laden with homeward-bound troops, ran aground on Jan. 2, 1919, in a fog off Fire Island, New York.



SAND MIXING MACHINE

The sternframe was broken just above the upper rudder lug, in a position where the casting is hollow and measures almost 2 feet in diameter. The walls of the casting at this point are about 3 inches thick. The weld which required 1400 pounds of thermit for the chemical production of the necessary amount of molten steel, and which was made without removing the casting from the ship, obviated the delay and expense which would have been entailed by the alternative of purchasing a new casting and installing it at a cost probably exceeding $50,000 and several months' delay.

In preparing the mold for the weld, 40 barrels of backing material and six barrels of facing sand were used. The metal was preheated for seven hours prior to the reaction.

A New Size Sand Mixer

The National Engineering Co., 549 West Washington boulevard, Chicago, manufactures its Simpson foundry mixer in two sizes, namely, 4 feet and 6 feet in diameter. Recently another size, 3 feet in diameter, has been developed. The new machine is constructed on the same lines as the larger ones and is a muller type of machine having an automatic discharge. Efficient results are claimed on account of the combination of mullers and plows. It is said the price and capacity of the small mixer will make it an advantageous investment by the smaller foundry owners who heretofore have not installed machines of this type because their business was not sufficient to keep one of the larger sizes working to capacity. Also in large foundries where it is not convenient to mix all the sand in one place, the small machine can be used to advantage as an auxiliary.

A patent recently issued to D. J. Reily and A. D. Mattei deals with a core sand mixture for foundry use. The mixture is composed of yellow clay, 25 per cent and sand, 75 per cent. The claim is made that it requires no binder of an organic nature.

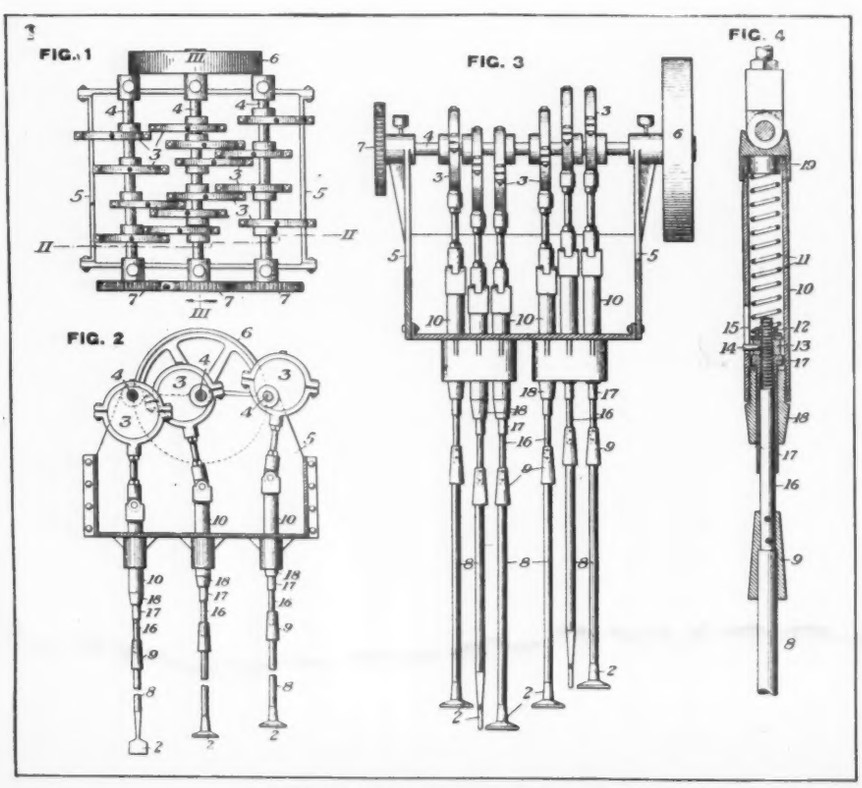
Develops Power Rammer for Molding Machines

In order to provide a power ram appliance for molding machines, an inventor, G. W. Wendell, Johnstown, Pa., recently developed the patented device shown in the accompanying illustration. It is claimed that the machine is simple in design and that it operates efficiently. Briefly described, it consists of three shafts, mounted in a frame and driven by spur gearing, which actuate the rammers through the medium of eccentrics. Power is applied to the center shaft of the appliance by means of an overhead belt while the two side shafts are operated by gears driven from the center shaft.

In the accompanying illustrations, Fig. 1 is a plan view, Fig. 2 is a sectional side elevation on line II-II of Fig. 1, Fig. 3 is an end elevation, part of which is shown in section, while Fig. 4 is a sectional view which shows the actuatng connections used on the rammers.

The ramming tools, *2*, are of the same type used in ordinary hand ramming. They are driven by means of the eccentrics, *3*, which are installed on the shafts, *4*. These shafts revolve in journals in the frame, *5*. The eccentrics on each shaft are given different annular advances with each other as well as with the eccentrics on the other shafts so that the ramming tools will be successively operated. This is readily accomplished by timing the eccentrics to give the desired result and then securing them to the shafts by several set screws. The center shaft, *4*, is driven by the pulley, *6*, and imparts motion to the other shafts through the spur gears, *7*. Each of the rammers, *2*, is attached to a shank, *8*, which is mounted in a socket, *9*. In operating the machine, the inventor points out that it is necessary to provide adjustments to affect the length of the rammers and also the impact of the blows. To this end each of the rammers is provided with a sleeve, *10*, which carries a helical spring, *11*. This spring seats on its lower end on a washer, *12*. This washer, in turn, rests on the nut, *13*, which is kept from turning by means of a pin, *14*. This pin engages the slot, *15*. The nut, *13*, is threaded on the upper end of the rod, *16*, which is connected with the socket, *9*. The lock nut, *17*, is for the purpose of locking the mechanism against turning. A guide sleeve, *18*, is screwed into the lower end of the sleeve, *10*, at the upper end of which is a bearing block, *19*. This block takes the thrust from the spring, *11*. The bearing blocks, *19*, can be made of different heights so as to increase or decrease the spring tension. By this means, the rammer blows can be regulated. In operation, the device is mounted on supports above the mold to be rammed. These supports, however, are not shown in the illustration.

A core oil mixture, recently patented, consists of linseed oil, 24 parts; rosin, 33.6 parts; light petroleum distillate, 29.8 parts and kerosene, 12.5 parts.

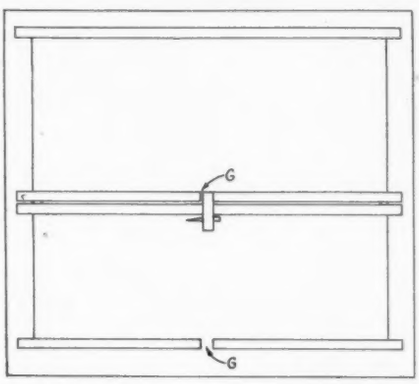


DETAILED DRAWING OF POWER RAMMER

Guides for Iron Flasks

Iron flasks which are fitted up for use on molding machines or for special jobs are provided with permanent and interchangeable means of locating the different parts in relation to each other. All the pin holes are bored through a jig and are of the same size. Different conditions prevail however in general jobbing work. In some cases only a single flask is used; in other cases several sections are built on top of each other and in many cases there are one or more cheeks to be taken care of. This is especially true in the case of round flasks.

A convenient method of locating iron flasks in relation to each other is shown in the accompanying illustration. When the flasks are being molded small rectangular pieces of cake core are dropped in the flange at convenient intervals. These will leave gaps such as that



A CLAMP AND WEDGE GUIDE FOR AN IRON FLASK

shown at *G*. Two, three or more gaps may be provided depending on the size of the flask. When the time comes to use them, it is merely necessary to place a clamp in the gap and then drive a wedge between the lower lug of the clamp and the flange.

It is not claimed that this system is better than providing drilled holes and machined pins, but it is believed that it is just as accurate and leaves the foundry independent of the machine shop as far as fitting is concerned. Furthermore if long round pins happen to be left in iron flasks they are almost sure to be bent when the flasks are taken apart for the purpose of shaking them out. A clamp and a wedge are fool proof.

It is claimed by one inventor that if ingot molds for brass are coated with aluminum paint, a greatly improved ingot results. Also, that if the cast iron from which the molds are made is alloyed with over 2 and not more than 5 per cent of aluminum, they will last longer and produce ingots free from blowholes.

Book Reviews

Analysis of Babbitt, by James Brakes, chief chemist, Chateaugay Ore & Iron Co.; 5 x 7 inches; published by the Allen Book & Printing Co.; furnished by THE FOUNDRY for $2.50.

This book is entitled "Analysis of Babbitt" and the author says it is his desire to place before mining, civil, electrical and mechanical engineers and others who have chemical training a small practical book on the analysis and manipulation of babbitt. While it has been written primarily for men with chemical knowledge, still the basic underlying principles are described in plain language which can be understood by the ordinary layman.

Each of the constituents of babbitt metal is treated of exhaustively. References are made under each heading to books and articles on this subject by authors located in different parts of the world. A key letter is attached to each reference. The last page contains a list of publishers' names together with the explanation of the key.

Metal Worker's Handy-Book of Recipes and Processes; by William T. Brannt; cloth; 580 pages, 5 x 7¼ inches; published by Henry Carey Baird & Co., Inc., and furnished by THE FOUNDRY for $3 net.

This is a reference book for any person engaged in the working of metals. It contains a comprehensive collection of formulas and descriptions of practical manipulations for the working of all kinds of metals and alloys, including the decoration and beautifying of articles manufactured therefrom as well as their preservation. The present volume is a new edition and contains several new chapters on oxyacetylene, thermit and electric welding, galvanizing, sherardizing, the Schoop spray process and die casting.

The Marshall Casting Co. which operated a plant for the past year at South Haven, Mich., has been taken over by Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., and will be known as the National Motor Castings Co. Gas engine manifolds have formed the principal product of this foundry.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

A small plant addition will be erected by the Buhl Malleable Co., Detroit.

M. Hayman & Co., 856 East Ferry street, Buffalo, has taken out a permit to erect a foundry building.

The plant of the McKim Foundry & Machine Co., Lockport, N. Y., recently was damaged by fire.

The Duplex Mill Co., Springfield, O., recently took out a permit to erect a foundry, 45 x 50 feet.

Gustave Shoener will erect a foundry at 80-84 Newark street, Newark, N. J.

A foundry is being erected at Ottawa, Ont., by the Beach Foundry Co.

Peter Leonard, South Salem, Mass., is building an iron foundry, 56 x 103 feet.

An addition is being erected at the plant of the Detroit Gray Iron Foundry Co., Detroit.

Contracts are being let for the construction of brass works and foundry buildings at the plant of the Peninsular Brass Works, Detroit.

The Austin Co., Cleveland, has a contract to erect a foundry building for Kern Dodge, Morris building, Philadelphia, to be 116 x 180 feet.

Bids will be called for shortly by the United Iron & Machinery Co., Haileybury, Ont., for the erection of a foundry and machine shop.

Rapid progress is being made on the erection of a foundry at Sarnia, Ont., for the Romeo Foundry Co., Port Huron, Mich.

The Bosworth Ard Machine & Foundry Co., Montgomery, Ala., recently applied for a charter with an authorized capital of $50,000.

Erection of a foundry, 70 x 200 feet, is contemplated by the Arneson Foundry Co., Kenosha, Wis., of which O. Arneson is president.

Bids are being taken for the erection of a brass plant for the West Virginia Metal Products Co., Fairmount, W. Va.

The foundry building of the Rhinelander Iron Works, Rhinelander, Wis., recently was damaged by fire. The loss was partly covered by insurance.

The Dodge Steel Co., Philadelphia, has let a contract to the Austin Co., Cleveland, for the erection of a foundry building, 116 x 800 feet.

A foundry is included in a new industrial plant to be built at York, Pa., by Harry Read and others. Other buildings will include an iron working and erecting shop, a machine shop and offices.

The East Penn Foundry Co., Macungie, Pa., is building a foundry addition to its present plant and is having plans prepared for a second addition. Some new equipment will be installed.

A plant will be erected by the Fulton Foundry & Machine Co., West Seventy-fifth street and Morgan avenue, Cleveland.

A building, 37 x 59 feet, will be erected at the plant of the Standard Brass Foundry Co., 990 East Sixty-seventh street, Cleveland.

Erection of a foundry, 65 x 80 feet, is contemplated by the Taylor Iron Works, Macon, Ga. Some new equipment is needed.

A foundry, 35 x 193 feet, will be constructed by the Wendling Construction Co. for Russell & Co., South Erie street, Massilon, O.

Erection of an addition to its foundry is under contemplation by the Bridgeport Brass Co., Bridgeport, Conn.

The Crompton & Knowles Loom Works, Worcester, Mass., will increase its foundry storage capacity for iron and coke.

E. L. Sackett, manager of the Teluride Iron Works, Greeley, Colo., is reported contemplating the erection of a small iron foundry.

Work has started on the erection of additions to the plant of the Regent Brass Foundry Co., Marysville, O.

Price Bros., East Patrick street, Frederick, Md., recently awarded a contract for the erection of a machine shop and foundry, 37 x 160 feet.

The Acme Foundry Co., 5217 Sweeney avenue, Cleveland, has acquired a site on which it plans to build an addition to its plant, 75 x 100 feet.

Erection of a plant addition, 80 x 100 feet, is being contemplated by the Sunray Stove Co., Delaware, O.

A foundry and machine shop, 90 x 240 feet, will be erected by the United Roll & Foundry Co., Ravenna, O.

The pattern shop of the Western Tool & Machine Co., Holland, Mich., recently was badly damaged by fire.

The Pittsburgh Malleable Iron Co., Pittsburgh, recently increased its capital from $300,000 to $1,000,000.

Erection of a modern steel foundry is contemplated by officials of the American Frog & Switch Co., Hamilton, O., according to a current report.

A recent Michigan incorporation is that of the Production Foundries Co., Ann Arbor, Mich. This company, which is capitalized at $100,000, is backed by men interested in the Ann Arbor Machine Co.

Plans have been filed by the Brady Brass Co., 170-184 Fourteenth street, Jersey City, N. J., for the erection of a plant addition.

A foundry, 100 x 107 feet, will be erected by the Michigan City Foundry Co., Michigan City, Ind. J. M. Hirschste, 5777 De Giverville avenue, St. Louis, is architect.

Contracts for the erection of a pattern shop to be built at Philadelphia, have been awarded by the Bureau of Yards and Docks, Navy department, Washington.

The Singer Mfg. Co., 149 Broadway, New York, recently awarded contracts for the erection of a foundry, 176 x 252 feet, to be built at Elizabeth, N. J.

The Wabash Foundry Co., Wabash, Ind., intends to enlarge its plant within the next 90 days. A new cupola is now being installed and additional equipment will be installed in the machine shop.

To permit of future expansion, the Muncie Foundry & Machine Co., Muncie, Ind., has purchased several lots adjoining its plant. At present only one building will be erected. It will be 40 x 40 feet.

The Sterling Foundry Co., Wellington, O., recently was incorporated with $150,000 capital, by R. E. Clisby, C. M. Ross, V. M. Clisby, A. W. McHenry and S. H. Hummell.

Contracts have been awarded the Austin Co., Cleveland, for the erection of a small foundry, 27 x 40 feet, by the Homestead Valve Mfg. Co., Homestead, Pa.

Foster, Merriam & Co., Meriden, Conn., have let a contract for the erection of an addition, the first floor of which will be used as an extension to the foundry.

Westinghouse, Church, Kerr & Co., contractors and engineers, have the contract to erect a steel foundry for the Pettibone-Mulliken Co., 140 South Dearborn street, Chicago.

A foundry, 50 x 80 feet, will be erected by the Moore Plow & Implement Co., Greenville, Mich., of which D. H. Moore is president. The Charles C. Kawin Co., Chicago, is engineer in charge.

The Phoenix Construction Co., Montreal, Que., has been incorporated to manufacture tools and machinery and to operate a foundry. The company is capitalized at $100,000.

A recent New York incorporation is that of the Union Iron & Foundry Co., Buffalo. The company,

which is capitalized at $25,000 was incorporated by J. J. Fry, A. G. and M. A. Asbery.

The Standard Stove Co., Jamestown, N. Y., recently was incorporated with $500,000 capital by Patrick S. and John J. Guelmare and Henry Mueller, Jamestown, and Leo H. Ludwig, Falconer, N. Y.

H. C. Johnson, Ltd., Bank of Toronto building, Montreal, Que., has the general contract to erect a foundry building for the Canadian Steel Foundries, Ltd., 120 St. James street, Montreal.

Work has started on the erection of a plant for the Industrial Electric Steel Casting Co., Toledo, O. The plant will be equipped with four electric furnaces. L. S. Dukes is president.

The Erie Foundry Co., Erie, Pa., recently let a contract for the erection of a plant addition to be 80 x 200 feet. It is expected the improvement will nearly double the capacity of the plant.

Construction of a foundry will be undertaken shortly by the Gale Mfg. Co., Albion, Mich. Other improvements are contemplated. M. T. Conklin is president.

The Thatcher Propeller & Foundry Co., Albany, N. Y., recently filed plans for the erection of a cupola and mill building at Thatcher and Learned streets, Albany.

The L. & P. Mfg. Co., Niagara Falls, Ont., has been incorporated to conduct a general foundry business with $50,000 capital, by William La Bombard, Alexander W. Patterson and Charles Ballard.

The Chase Tractors Corp., Toronto, Ont., has been incorporated to carry on a steel and iron foundry business with $200,000 capital, by James L. Ross, Arthur W. Homestead and others.

The Des Moines Foundry & Machine Co., Des Moines, Iowa, will erect a plant on property recently purchased by Emil Schmidt, whose son, C. W. Schmidt, is president of the company.

Additional land has been purchased at Janesville, Wis., by the General Motors Corp., for its Samson tractor plant. Several units of the plant have been completed, and the next unit to be erected will be the foundry.

Among the recent incorporations is that of the Kent Foundry Co., Grand Rapids, Mich. This company, which is capitalized at $5000, was incorporated by Hiram Engbers, William H. Duffy and Lewis E. Davis.

Riesen Bros. Co., 425 East Water street, Milwaukee, are the general contractors on the gray iron and semisteel foundry, 111 x 180 feet, to be erected at West Allis, Wis., for the Motor Castings Co., 86 Michigan street, Milwaukee.

A recent incorporation is that of the Illinois Pattern & Foundry Co., Geneva, Ill. This company, which is capitalized at $50,000, was incorporated by R. H. Mather, Lawrence C. Traeger and A. W. Odegaard.

Within the past month the McLain-Carter Furnace Co., Milwaukee, has installed 5-ton open-hearth furnaces in the plants of the Lima Steel Casting Co., Lima, O., and the McDougall-Duluth Co., Duluth, Minn.

Among the recent Pennsylvania incorporations noted is that of the Indiana Foundry Co., Indiana, Pa. The company, which is capitalized at $150,000, was chartered by Thomas, John W. and R. S. Sutton all of Indiana.

A contract for engineering and construction work on alterations and extensions to its foundry, has been awarded the Austin Co., Cleveland, by the Superior Foundry Co., Cleveland, which also plans to build a 2-story building, 75 x 200 feet, to be used as a core department when completed.

The Nelson Corp., Boston, recently was incorporated to operate a foundry and machine shop with $50,000 capital. Albert H. Nelson, Mason H. Stone, Newton, Mass., and A. C. Bartlett, have been named as incorporators. A plant will be erected at Cambridge, Mass.

The Douglas Bros. Foundry, a pioneer industrial plant at Aberdeen, Wash., has been sold to a combination of Aberdeen and outside capitalists, represented in the transaction by H. P. Hoonan Jr. and S. P. Knight. The foundry was established in 1897.

A permit has been issued to the Pacific Brass & Steel Foundry, Portland, Oreg., to erect a new foundry building. Additional equipment will be installed.

Contracts for the erection of two additions, 100 x 100 feet and 40 x 50 feet, recently were awarded by the Springfield Foundry Co., Springfield, Mass.

The foundry operated by Lord, Stone & Co. at Otter River, Mass., which was recently purchased by W. L. Shaughnessy and J. P. Carney of the William L. Shaughnessy Co., Gardner, Mass., will be incorporated as the Otter River Foundry Co., with $50,000 capital.

A recent Cleveland incorporation is that of the Carnegie Pattern Works Co., which is capitalized at $10,000. The incorporators are Joseph Dembe, H. R. McManamon, J. M. Hardy, W. M. Monroe and John M. Bell. The company's office is at Carnegie avenue and East Fifty-fifth street.

Certificate of increase in capital stock and providing for preferred stock was filed recently by the Charles B. Bohn Foundry Co., Detroit. The company's capital will be increased from $500,000 to $1,000,000. Contracts have been awarded for the erection of a power house.

A. H. McDonald, E. H. Olsen, James E. Foubister and Charles M. Magnuson are incorporators of the Duluth Foundry & Faucet Co., Duluth, Minn., which was recently incorporated with $50,000 capital.

The new plant of the Southern Foundry & Machine Co., at Sixth and Cross streets, Chattanooga, Tenn., has been completed and machinery is to be installed shortly. The plant will be under the management of Edward Herron, now manager of the American Brakshoe & Foundry Co.'s plant at Chattanooga.

Stockholders of the H. W. Cooper Saddlery Hardware Mfg. Co., Moline, Ill., at a recent meeting changed the name of the company to the Moline Iron Works, and decided to double the capacity of the plant. The first unit is to be a 2-furnace malleable iron foundry. L. E. Nutt is president of the firm.

New Trade Publications

TOOL STEEL.—A booklet entitled "Tool Steel Efficiency" has just been issued by the Century Steel Company of America, Poughkeepsie, N. Y. The evolution of tool steel is traced from its earliest beginning to its present highly developed state. The various brands of steel manufactured by the Century company are described and type analyses of most of the brands are given.

CORE OVENS.—The Foundry Equipment Co., Cleveland, has prepared a 44-page illustrated booklet, in which it describes and illustrates core and mold ovens. The information given is general and the illustrations show typical installations. These ovens are built for operation with portable racks, rolling drawers, shelves, cars or combinations of these, and are built to be operated by coke, oil, gas, powdered coal for fuel.

BLOWERS.—Much valuable information on rotary positive blowers, gas exhausters, pumps and vacuum pumps, couplings, blast gates, relief valves, feed devices and governors is contained in a bulletin issued by the P. H. & F. M. Roots Co., Connersville, Ind. Complete tables giving sizes best fitted for various uses with capacity, speeds and other data useful to the engineer feature this bulletin. The principle utilized in the impellers and blowers made by this company is clearly set forth. Many illustrations assist in making plain the text.

DRINKING WATER SYSTEM.—The Armstrong Cork & Insulation Co., Pittsburgh, is circulating a 4-page leaflet in which its describes a modern system for the delivery of drinking water to convenient parts of factories, etc. This system according to the booklet has been shown to be healthful and economical. The system consists of water fountains placed at convenient parts of the plant. The company has issued a 48-page booklet, in which the subject of drinking water systems is explained more thoroughly.

OPEN-HEARTH EQUIPMENT.—Ports, valves and slag pockets are described in an illustrated booklet recently published by the Blair Engineering Co., Chicago. With this company's port, according to the booklet, complete control of the combustion and direction of the gas at all times is possible. Another feature is that the roof and side walls need not be rebuilt because of a general repair caused by the burning down of the ports, but either roof or side walls can be replaced when worn out. Chapters on valves and slag pockets describe each thoroughly.

LOCOMOTIVE CRANES.—The United States Crane Co., Chicago, has just issued a 16-page buletin describing a 20 to 30-ton locomotive crane for grab bucket, hook block or magnet service. The crane described is mounted on a cast steel frame supported by two 100,000-pound capacity trucks. The boom is 50 feet long and the safe lifting capacity of the crane without track clamps is 10 tons at a 15-foot radius or 4 tons at a 50-foot radius. All parts of the crane are described and illustrated.

METAL HOSE.—The Breeze Mfg. Co., Newark, N. J., has published an interesting 36-page booklet dealing in detail with flexible metal hose. This, according to the company, is the only booklet ever published in this country on the subject. The descriptive matter covers metal hose in detail for every type and method of winding, showing how it is applied, etc., and the trades and industries which use it are given. The booklet is replete with information which should prove not only interesting but valuable.

PNEUMATIC CONTROLS.—The Parker Appliance Co., Cleveland, is distributing a small booklet devoted to pneumatic controls for commercial vehicles. A system of air brakes for use on motor trucks and trailers is described and illustrated. The equipment consists of a compressor mounted on the motor, a storage tank, an unloader, which automatically relieves the pump when the working pressure is excessive, a distributing valve, a hand control and brake cylinders. A diagram of the various parts of the equipment and the necessary piping for motor trucks and trailers is shown.

BUCKET CRANES.—An illustrated folder of 4 pages prepared by the Whiting Foundry Equipment Co., Harvey, Ill., describes and illustrates bucket cranes. Most of the illustrations are of actual installations and show cranes employed at the plants of the Scranton Electric Co., Scranton, Pa., handling coal; serving a cinder pit of the Western Maryland railroad at Hagerstown, Md.; handling cement clinker at Sandusky Portland Cement Co., Dixon, Ill., and handling coal in the milling plant of the Northwestern Consolidated Milling Co., Minneapolis. Lists of railroads and steel plants using this type of crane and showing the capacity of each crane are given.

ELECTRIC COMPRESSORS AND DRILLS.—An attractive 36-page booklet describing electric air compressors, portable electric drills and electric valve grinders, has just been published by the Black & Decker Mfg. Co., Baltimore. The air compressors described are of an unusually compact design and consist of a motor which imparts power to a piston by means of a train of gears and a connecting rod. The air passes from the cylinder into a condensation chamber, from which it is delivered for use. The compressors are made in various sizes and for various purposes. The electric drills described are equipped with a pistol grip and a trigger switch, and are made in six sizes, varying in capacity from $\frac{3}{16}$ to $\frac{7}{8}$-inch diameter holes in steel. The electric valve grinder is similar in many respects to the small electric drill, the spindle being fitted with a detachable bit.